

# Railway Mechanical Engineer

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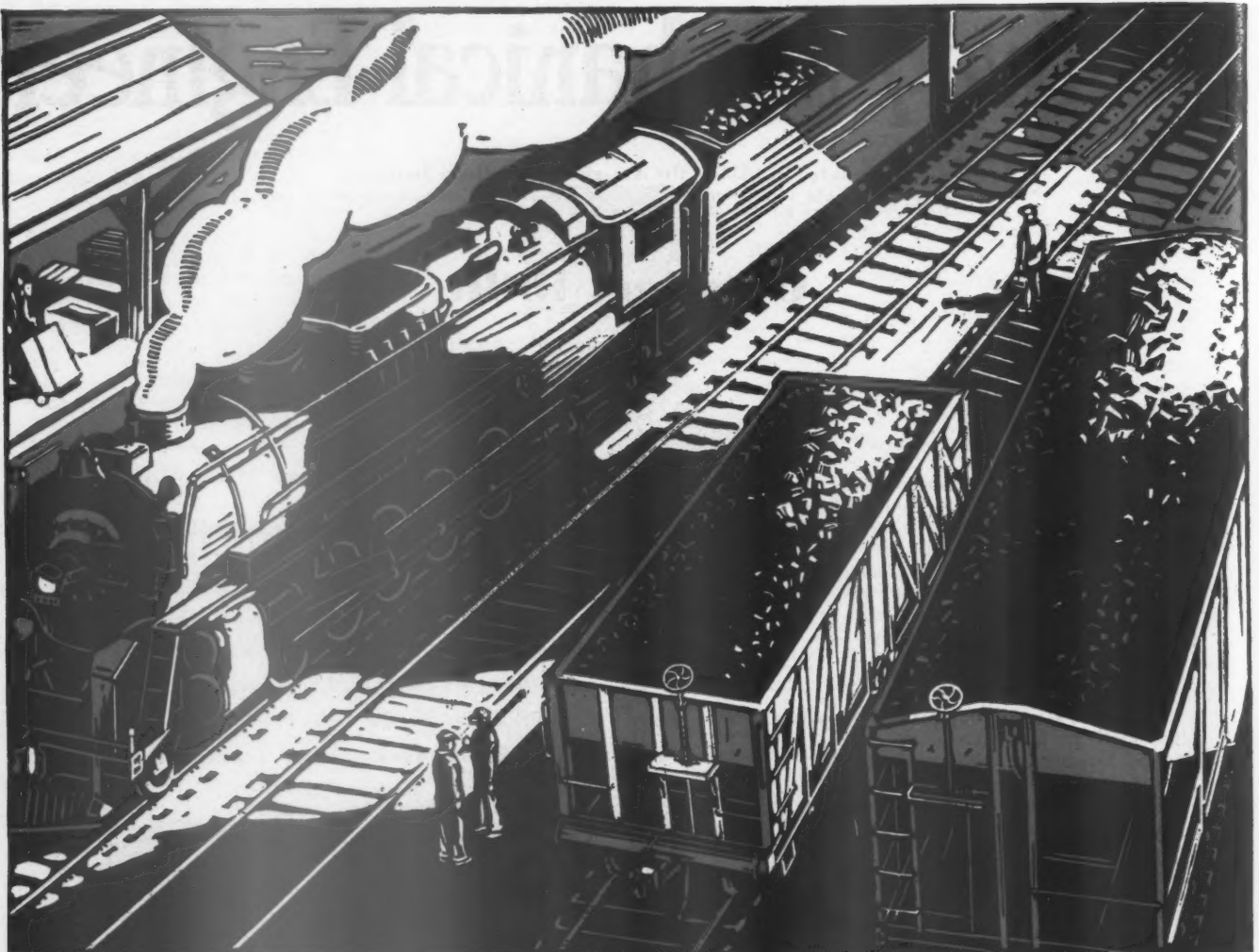
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You'll be a freight house bye and bye!"

This little ditty originated years ago when a 40-ton freight car was "big." Today there are 120-ton capacity cars in regular service. Freight train length and locomotive capacity have increased at even a faster pace. \* \* \* With this progress has come corresponding need for materials to withstand the constantly increasing severity of locomotive service. \* \* \* Republic metallurgists anticipated this need and have developed special alloy irons and steels that are improving locomotive performance and lowering maintenance costs. \* \* \* When axles, rods and pins encounter high stresses there are Agathon

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# Republic Steel

## C O R P O R A T I O N

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**Large Boiler and Roller Bearings Feature**

# N. & W. LOCOMOTIVES



**D**URING May and June of this year the Norfolk & Western turned out of its Roanoke, Va., shops two simple articulated locomotives having roller bearings installed on all engine and tender wheels and the largest boilers which have as yet been built for any N. & W. locomotive. These locomotives have been built for fast freight service where speeds of 60 to 65 m. p. h. are required and tests which have been made indicate the ability of this power to perform satisfactorily. Road tests show that these locomotives can handle 4,800-ton trains on a 0.5 per cent grade at 25 m. p. h. without difficulty and that on comparatively level tangent track a speed of 64 m. p. h. has been attained with a 7,500-ton train.

Accompanying this article is a chart showing the drawbar pull and drawbar horsepower plotted from dynamometer tests made with one of these locomotives while handling a merchandise train where the tonnage was relatively low and the speed high. The curve showing drawbar horsepower (which is on level track) shows that the locomotive develops over 6,000 horsepower at speeds from 32 to 57 m. p. h., with a maximum of 6,300 hp. at 45 m. p. h.

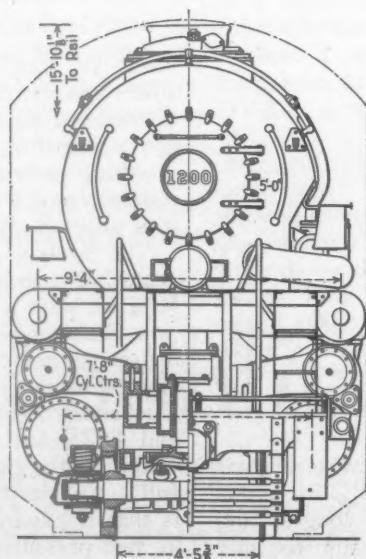
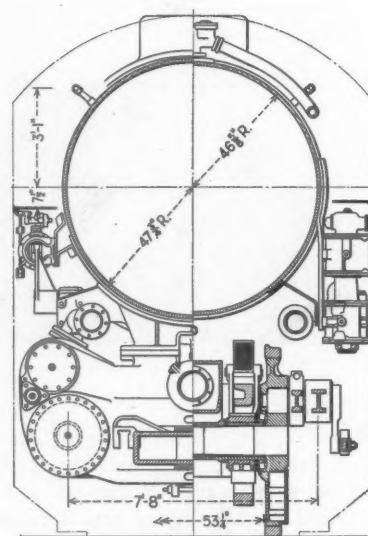
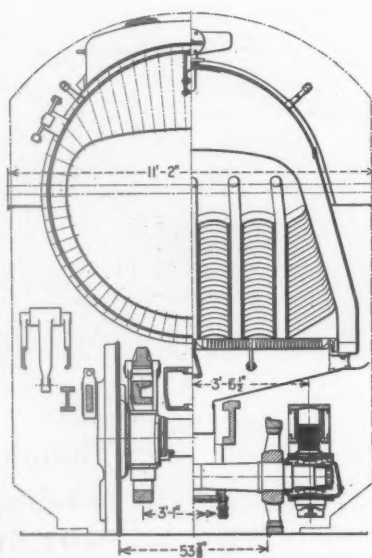
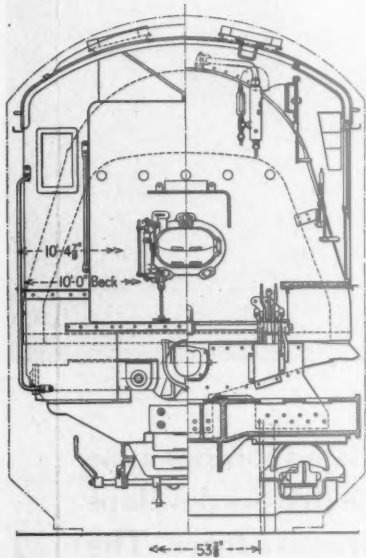
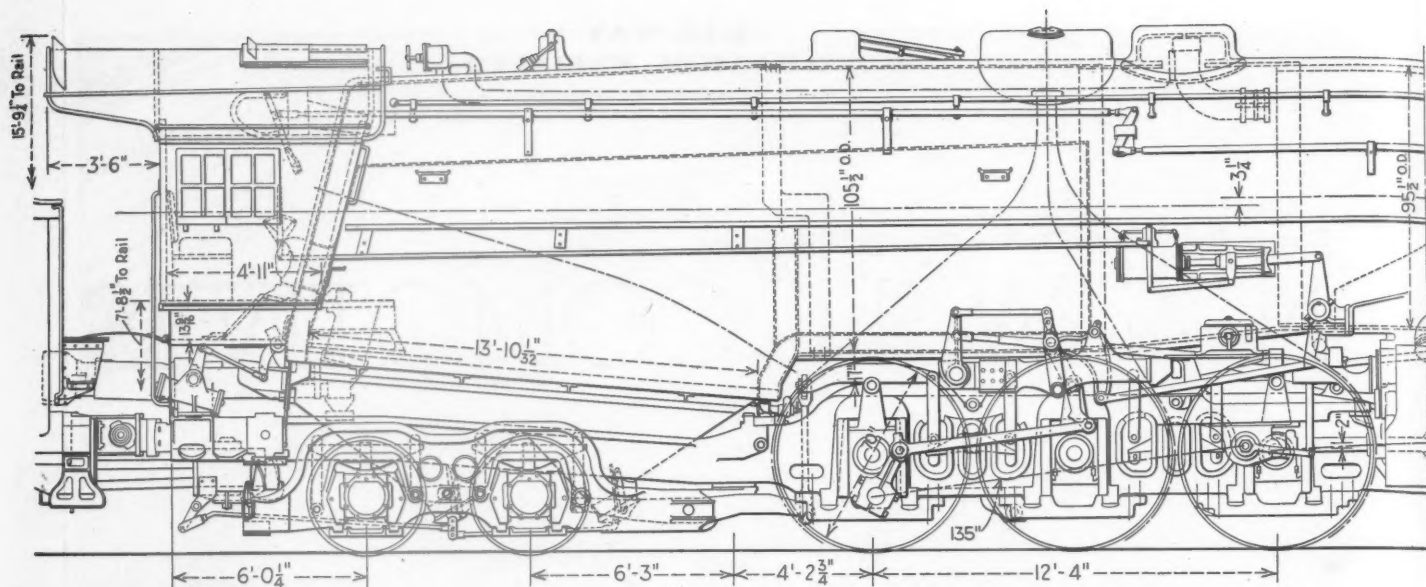
## **The Boiler**

The boilers are of particular interest because of their size. With an overall length of 60 ft. 9 $\frac{3}{16}$  in. and a light weight of 148,500 lb. they are the longest and heaviest boilers that have been built to date for any

**Simple articulated 2-6-6-4 type  
having 70-inch drivers develops  
104,500 lb. tractive force. The  
total weight is 948,600 lb. and  
the overall length 120 ft. 7 $\frac{1}{2}$  in.**

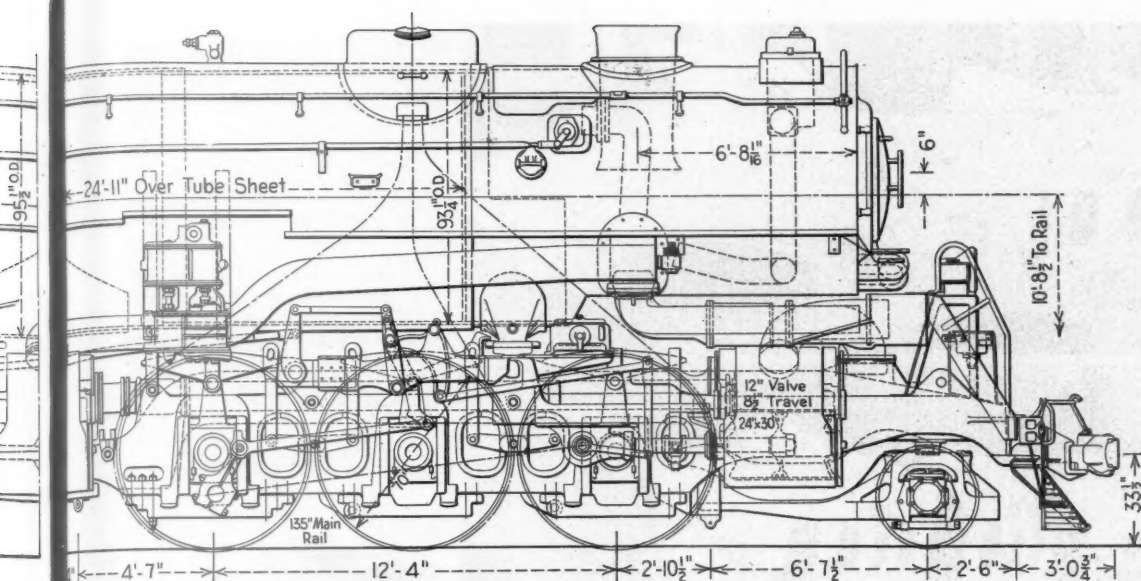
N. & W. locomotives. The barrels are constructed in four courses ranging in diameter from 91 in. inside diameter at the first course to 105 $\frac{1}{2}$  in. outside diameter at the fourth course. The two front courses have 1 $\frac{1}{8}$ -in. thick carbon steel sheets and the third and fourth courses have 1-in. and  $\frac{3}{4}$ -in. sheets of nickel steel. The roof sheet is  $\frac{3}{4}$ -in. nickel steel.

The firebox is electrically welded throughout. The grate has a length of 13 ft. 10 in. and a width of 8 ft. 10 $\frac{1}{4}$  in. with a grate area of 122 sq. ft. The combustion chamber is 9 ft. 8 in. long. The boiler has 239 3 $\frac{1}{2}$ -in. diameter superheater flues and 57 2 $\frac{1}{4}$ -in. diameter tubes. The length of the flues is 24 ft. 1 in. The construction of each boiler involved 2,970 rivets and 4,925 staybolts. The boiler holds 8,100 gallons of water at the working height and 9,835 gallons when full. An interesting fact in connection with the boiler is that it expands in length 1 $\frac{1}{16}$  in. from cold to 330 lb. test pressure.



Above (left and center) cross sections at firebox and combustion chamber and back head

Above (right), section through driver and at rear engine cylinders and (below at the left) a front end view



Side elevations of the new Norfolk & Western locomotive

The boilers are designed for a working pressure of 300 lb. per sq. in., but are set to work at 275 lb. The grates used are of the N. & W. standard design and coal is fed by a Standard Type MB stoker. The firebox is equipped with a Security brick arch having five 3 1/2-in. arch tubes.

The boiler is fitted with an Elesco Type E superheater, with an American multiple throttle and a Worthington Type 6-s-A feedwater heater having a rated capacity of 12,000 gallons per hour. A Nathan live-steam injector of the horizontal non-lift type with a rated capacity of 10,000 gallons is used. The safety valve equipment consists of four Ashton 3 1/2-in. Type FC-10 valves.

These locomotives are of the single-expansion articulated type and have four cylinders, cast integral with the frames, 24 in. in diameter by 30 in. stroke. With

#### General Dimensions, Weights and Proportions of the N. & W. 2-6-6-4 Type Locomotive

Railroad	Norfolk & Western
Builder	Railroad company
Type of locomotive	2-6-6-4
Road Class	"A"
Road numbers	1200 and 1201
Date built	May and June, 1936
Service	Fast freight
<b>Dimensions:</b>	
Height to center of boiler, ft. and in.	10-5 1/4
Height to top of stack, ft. and in.	16-0
Width overall, in.	134
Cylinder centers, in.	92
<b>Weights in working order, lb.:</b>	
On drivers	430,100
On front truck	30,300
On trailing truck	109,600
Total engine	570,000
Tender	378,600
<b>Wheel bases, ft. and in.:</b>	
Driving	35-5
Rigid	12-4
Engine, total	60-4 3/4
Engine and tender, total	108-7 1/4
Trailing	5-0
<b>Wheels, diameter outside tires, in.:</b>	
Driving	70
Front truck	36
Trailing truck	42
<b>Engine:</b>	
Cylinders, number, diameter and stroke, in.	4-24 x 30
Valve gear, type	Baker
Valves, piston type, size, in.	12
Maximum travel, in.	8 1/2
Steam lap, in.	2
Exhaust clearance, in.	1/16
Lead, in.	3/4
Cut-off in full gear, per cent.	75

#### Boiler:

Type	Conical
Steam pressure, lb. per sq. in.	275
Diameter, first ring, inside, in.	91
Diameter, largest, outside, in.	105 1/2
Grate, length, in.	166 1/2
Grate, width, in.	106 1/4
Height mud ring to crown sheet, back, in.	70 3/4
Height mud ring to crown sheet, front, in.	93 3/4
Combustion chamber length, ft. and in.	9-8
Arch tubes, number and diameter, in.	5-3 1/2
Tubes, number and diameter, in.	57-2 1/4
Flues, number and diameter, in.	239-3 1/2
Length over tube sheets, ft. and in.	24-1
Net gas area through tubes and flues, sq. ft.	11.24
Fuel	Bituminous
Stoker	Standard Mod. Type "B"
Grate type	N. & W. Std.
Grate area, sq. ft.	122

#### Heating surfaces, sq. ft.:

Firebox and comb. chamber	530
Arch tubes	57
Firebox, total	587
Tubes and flues	6,063
Evaporative, total	6,650
Superheating (Type E)	2,703
Combined evap. and superheat	9,353
Feedwater heater, type	Worthington 6-S-A
Live steam injector	Nathan

#### Tender:

Style or type	Rectangular
Water capacity, U. S. gal.	22,000
Fuel capacity, tons	26
Trucks	Six-wheel

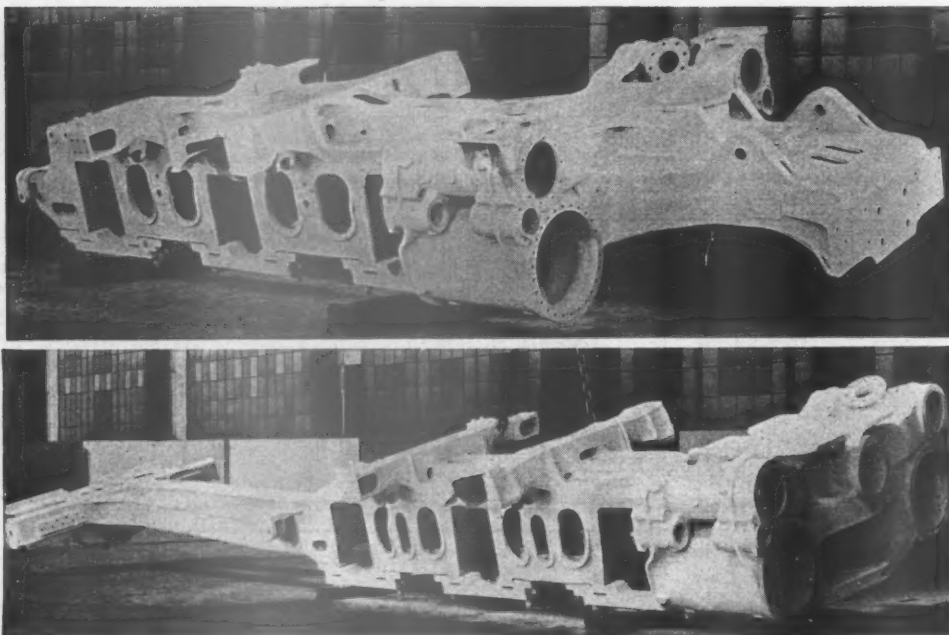
#### General data, estimated:

Rated tractive force, engine, 75 per cent cut-off, lb.	104,500
Speed at 1,000 ft. per min. piston speed, m.p.h.	41.6
Piston speed at 10 m.p.h., ft. per min.	240.1
R.p.m. at 10 m.p.h.	48

#### Weight proportions:

Weight on drivers + weight, engine, per cent.	75.5
Weight on drivers + tractive force	4.12
Weight of engine + comb. heat. surface	61.0
Firebox heat. surface, per cent comb. heat. surface	6.28
Tube-flue heat. surface, per cent comb. heat. surface	64.9
Superheat. surface per cent comb. heat. surface	28.9
Firebox heat. surface + grate area	4.8
Tube-flue heat. surface + grate area	49.7
Superheat. surface + grate area	22.2
Comb. heat. surface + grate area	76.7
Gas area, tubes-flues + grate area	.0921
Tractive force + grate area	857.0
Tractive force + comb. heat. surface	11.2
Tractive force x dia. drivers + comb. heat. surface	782.1

275 lb. boiler pressure and 70-in. driving wheels they have a rated tractive force of 104,500 lb. The cylinders are spaced 92 in. on centers and have 12-in. piston valves with a maximum travel of 8 1/2 in. The steam lap is 2 in., the exhaust clearance is 1/16 in. and the lead 1/4 in. The maximum cutoff is 75 per cent. The valves are operated by Baker valve gear which is controlled



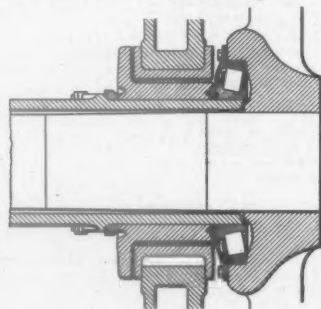
The front (top) and rear (bottom) units of the cast steel beds embodying the frames, cylinders and cross members. The two castings have a total weight of 110,925 lb. and their use displaced over 700 parts

by an Alco Type H reverse gear. The crossheads and guides are of the multiple-bearing type. The axles, crank pins and rods are of open-hearth carbon-steel forgings, normalized.

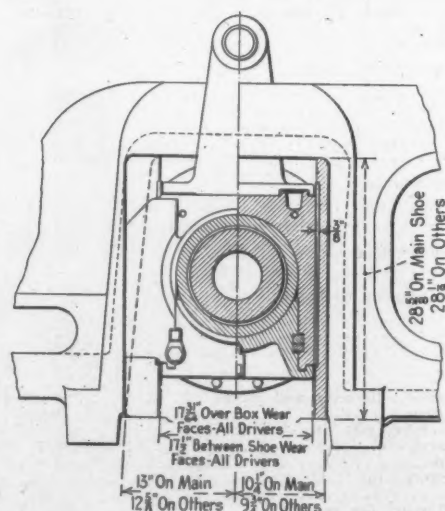
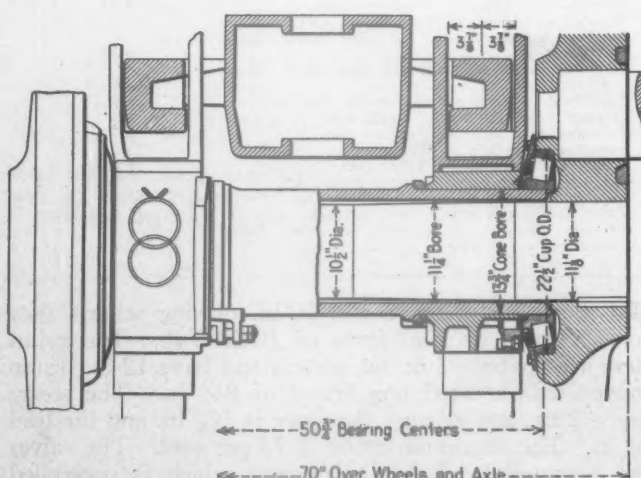
### Roller Bearings

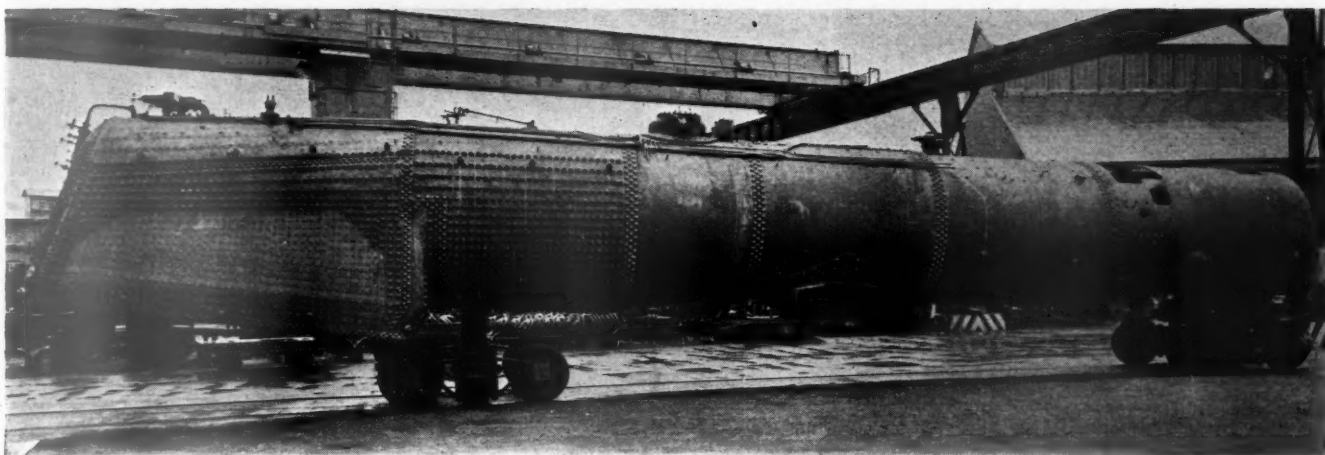
All of the wheels of both engines are equipped with Timken roller bearings. The tender of one engine has Timken roller bearings; the other has A.S.F. roller-bearing units. The driving-wheel installation is of special interest because it is the first of its kind. The driving-wheel assembly consists primarily of the wheels and axles, the axle tube or sleeve, the roller bearings and the driving boxes. The roller bearings are recessed into the driving-wheel hubs and the driving axles

carry none of the locomotive weight, the weight being carried by the tubes. The outer races of the roller bearings are fitted into a recess in each driving-wheel hub and the inner races are pressed onto the ends of a finished axle sleeve, or tube. The axle tube is supported in the driving boxes. The axles are hollow bored and in assembling the wheels and bearings the axle is pressed into one driving wheel. The tube, with the roller bearings slipped on each end, is placed over the axle. The other driving wheel is then pressed onto the axle, after which the outer races of the bearings are placed in the recesses in the wheel hubs. The inner races of the bearings are then pulled to the ends of the sleeves inside the recesses in the wheel hubs where the rollers are made to contact the outer races. The as-

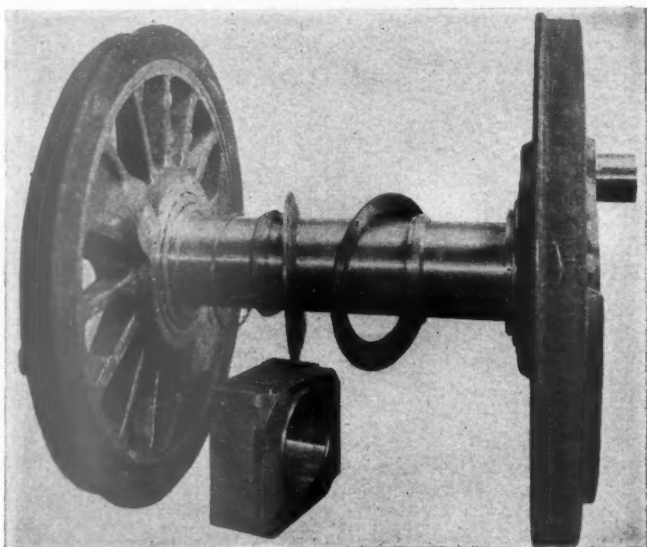


Drawing of the driving wheel roller bearing installation. At the left a cross section and plan section showing driving box and shoe and wedge and, at the right an end view and section at one pedestal showing lock key arrangement





Largest boiler ever built for a Norfolk & Western locomotive



A driving wheel assembly with the bearings in place in the wheel hubs and the enclosure plates shown on the axle tube



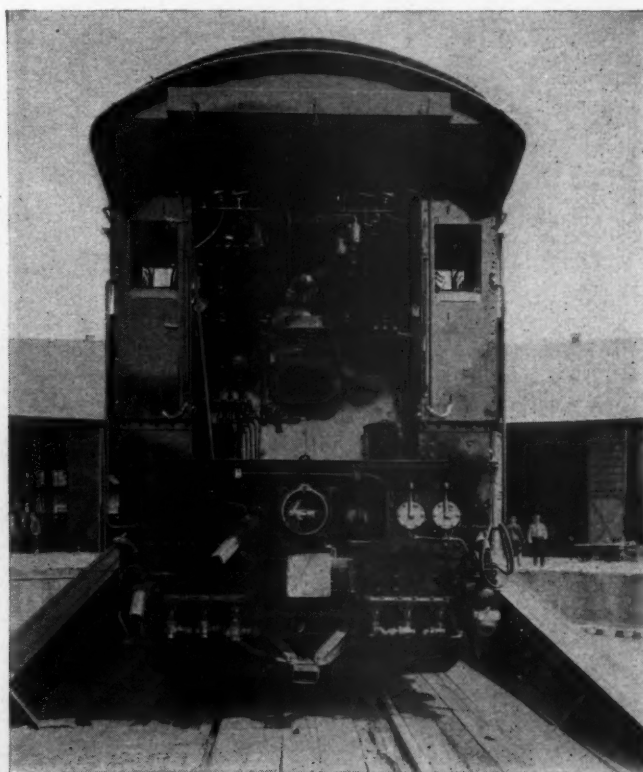
Wheel hub, showing the recess for the bearing race

sembly is completed by bolting the enclosure plates to the wheel hubs and clamping the driving boxes to the axle hub. This is accomplished by two pairs of wedges in the joints between the top and bottom sections of the driving box. The driving boxes are held in position on the tube by a backing ring on the inside end of each

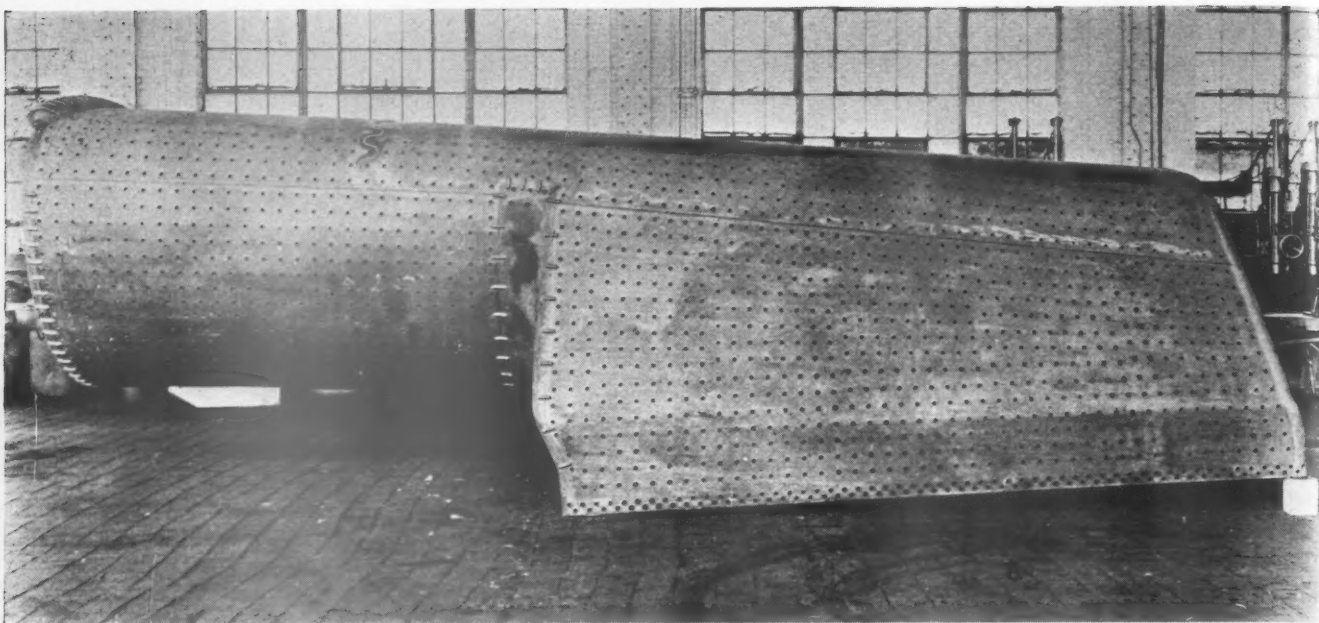
box and a three-piece adjusting spacer between the box and the inner bearing race. The driving boxes move vertically in the frame jaws between hardened bronze liners. The frame wedge is welded to the frame. The roller bearings are lubricated by grease which is forced into the bearing through fittings in the wheel hubs. The driving axles are of Timken design.

The roller bearings on the engine and trailer trucks are conventional Timken installations. The tender of one locomotive is mounted on Buckeye six-wheel trucks with Timken roller bearings, and the other tender has Commonwealth six-wheel trucks with A.S.F. roller-bearing assemblies.

The engine frames, cylinders and frame cross members are all cast integral in two bed castings weighing 110,925 lb. which were furnished by the General Steel Castings Corporation. By the use of these cast-steel frames it is estimated that 66 major parts and 634 minor parts were displaced. The two-wheel engine truck and



The cab and back head



The firebox and combustion chamber were electrically welded throughout

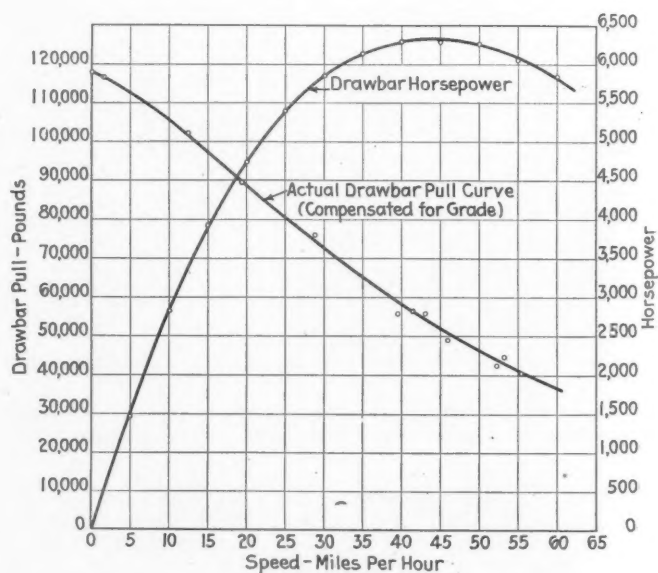
the four-wheel trailer truck frame castings were also furnished by the General Steel Castings Corporation.

High-pressure grease-gun fittings are used in numerous locations and two Nathan mechanical lubricators, actuated by the combination lever, supply oil from 33 leads to 72 outlets for the lubrication of the cylinders, steam chests, guides, steam-pipe slip joints, pedestal shoes and other surfaces.

The locomotives are equipped with Westinghouse

#### Special Equipment Applied on N. & W. 2-6-6-4 Type Locomotives

<b>Boiler:</b>	
Boiler steel, nickel, third and fourth course and roof	Bethlehem Steel Co.
Boiler steel, carbon, first and second course, and outside side sheets	Lukens Steel Co.
Firebox steel, firebox and comb. chamber	Lukens Steel Co.
Brick arch (Security)	American Arch Co.
Superheater (Type E)	Superheater Co.
Throttle valve, multiple	American Throttle Co.
Feedwater heater (Type 6-S-A), 12,000 g.p.h.	Worthington Pump & Machinery Corp.
Injector, live steam, 10,000 gal. cap.	Nathan Manufacturing Co.
Stoker (Mod. Type B)	Standard Stoker Co.
Firedoor (No. 9)	Franklin Railway Supply Co.
<b>Cab Fittings and Boiler Mountings:</b>	
Safety valves (Type FC-10), 4—3½ in.	Ashton Valve Co.
Water column	Nathan Manufacturing Co.
Bell ringer	Viloco Railway Equipment Co.
Sanders	Graham-White Sander Corp.
Reducing valve, steam heat (Type AL)	Leslie Co.
Headlight generator (Type E-3)	Pyle-National Co.
Headlight case, cast aluminum	Pyle-National Co.
<b>Cylinders and Driving Gear:</b>	
Valve gear	Pilliod Company
Packing, piston rod and valve stem	Paxton-Mitchell Co.
Cylinder cocks	Okadee Manufacturing Co.
Reverse gear (type H)	American Locomotive Co.
<b>Frames and Running Gear:</b>	
Frames, cast steel	General Steel Castings Corp.
Roller bearings, all engine and tender wheels	Timken Roller Bearing Co.
Roller bearings, tenders	Timken Roller Bearing Co. (1)
	American Steel Foundries (1)
<b>Lubrication:</b>	
Lubricators, mechanical	Nathan Manufacturing Co.
<b>Brakes:</b>	
Air brake (Schedule 8ET)	Westinghouse Air Brake Co.
Air compressors, 2—8½-in. cross-compound	Westinghouse Air Brake Co.
Driver brakes	American Brake Co.
Draft gear, tender (Type B-32-K)	Edgewater Steel Co.
<b>Tender:</b>	
Frame, water bottom	General Steel Castings Corp.
Buffer, radial (Type E)	Franklin Railway Supply Co.
Flexible connections	Franklin Railway Supply Co.
Trucks, six-wheel	Eng. 1200 "Commonwealth," General Steel Castings Corp.
	Engine 1201—Buckeye Steel Castings Co.



Drawbar pull-horsepower-speed curve

No. 8-ET brake equipment, including two 8½-in. cross-compound compressors, mounted under runboards on opposite sides of the boiler.

The rectangular water-bottom tender has a cast-steel frame which also forms the water bottom. The water capacity is 22,000 gallons and the fuel capacity is 26 tons. The loaded weight of the tender is 378,600 lb.

**Joy Ride**—A locomotive and six empty passenger cars were sent upon a brief, wild run in Baltimore, Md., recently, by a man who suddenly boarded the engine, slugged the engineman and jerked the throttle wide open. The heavy locomotive and the six cars ran off the end of the track at the Hillen station of the Western Maryland, plunged through a gate and plowed into a shed at the rear of the station. As the roof of the shed tumbled down about the locomotive, railroad employees rushed to the cabin to catch the man. It took eight men to subdue him. Later, 10 officers were required to quiet him at a police station. The identity of the man was not determined.

# Link Motion Valve Gear

## Part II

By J. Edgar Smith

**B**EFORE starting the actual layout of the Walschaert gear, it is well to calculate the lengths and proportions of such members as can be readily calculated. In order to do this it is necessary to continue considering the functions of the combination lever and the link separately. Fig. 7 shows the effect of the combination lever alone while Fig. 8 shows the effect of the link alone.

In Fig. 7, it will be noted that dimensions  $x$ ,  $y$  and  $z$  must be taken from the general plan of the locomotive

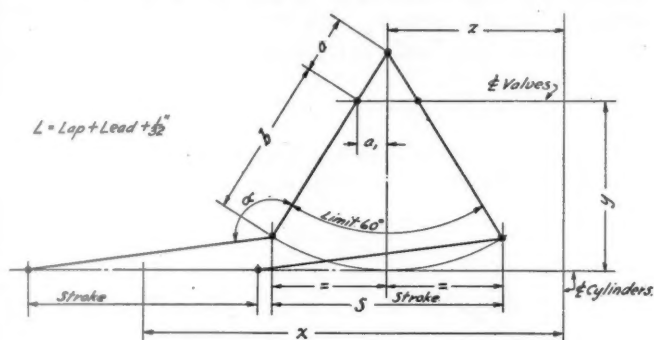


Fig. 7

under consideration. The extreme positions of the combination lever due to the motion of the crosshead should not exceed 60 deg., in order that the angle  $a$  be kept well within its limit of 135 deg.

In Fig. 8, it will be noted that angle  $\theta$  is taken at 40 deg., which is less than the recommended limit, in

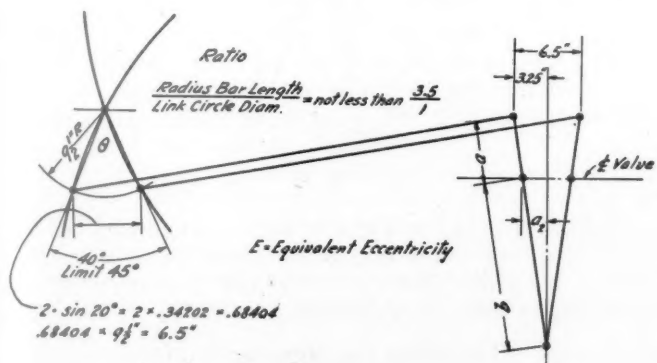


Fig. 8

order that the throw of the eccentric will not be excessive nor difficulty be encountered in holding the an-

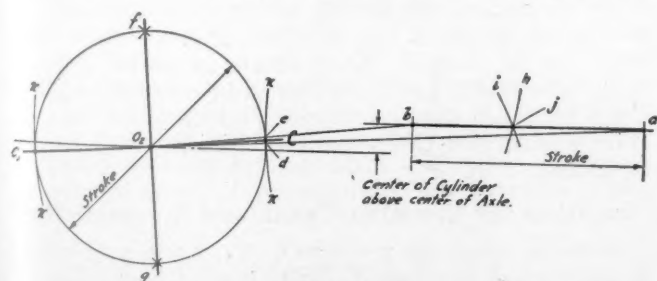


Fig. 9

## Laying out the gear — Effects of combination lever and link — Location of parts

gle between the eccentric rod and the link tail within the limit of 135 deg. The radius of the link circle is taken at 9 1/2 in. in order that full advantage may be taken of the motion of the link in proportioning the reversing mechanism. However, should the ratio of the radius rod length to the link circle diameter be less than 3.5 to 1, it would be necessary to reduce the link circle diameter.

### Derivation of the Formula for Combination Lever Proportions

From Fig. 7:—

$$a : a + b = a_1 : .5 S$$

or

$$a_1 = .5S \left( \frac{a}{a+b} \right)$$

since  $a_1 = \text{lap} + \text{lead}$  or  $L$ , this value should include 1/32 in. for lost motion in the pin connections.

From Fig. 8:—

$$b : a + b = a_2 : 3.25$$

or

$$a_2 = 3.25 \left( \frac{b}{a+b} \right)$$

$$a_2 = \text{equivalent eccentricity or } E$$

then

$$L : E = .5S \left( \frac{a}{a+b} \right) : 3.25 \left( \frac{b}{a+b} \right)$$

therefore

$$\frac{.5SEa}{a+b} = \frac{3.25Lb}{a+b}$$

$$.5SEa = 3.25Lb$$

$$a = \frac{3.25L}{.5SE} \times b$$

or

$$a = \frac{6.5L}{SE} \times b \text{ for } 9\frac{1}{2}\text{-in. link circle radius.}$$

Should it be necessary to select a shorter link circle radius, the following formulae may be used to correspond to the various radii:

Link circle radius	Formula
9 in. ....	$a = \frac{6.16L}{SE} \times b$
8 1/2 in. ....	$a = \frac{5.82L}{SE} \times b$
8 in. ....	$a = \frac{5.47L}{SE} \times b$
7 1/2 in. ....	$a = \frac{5.13L}{SE} \times b$
7 in. ....	$a = \frac{4.78L}{SE} \times b$

Link circle radius	Formula
6½ in. ....	$a = \frac{4.45 L}{SE} \times b$
6 in. ....	$a = \frac{4.11 L}{SE} \times b$

The upper arm of the combination lever should not be less than 2½ in. If possible, attach the union link directly to the crosshead pin as shown in Fig. 7. With the combination lever dimensions determined, the layout may be started, laying out at not less than 3 in. to 1 ft. scale, and starting with all the basic centerlines taken from the general plan.

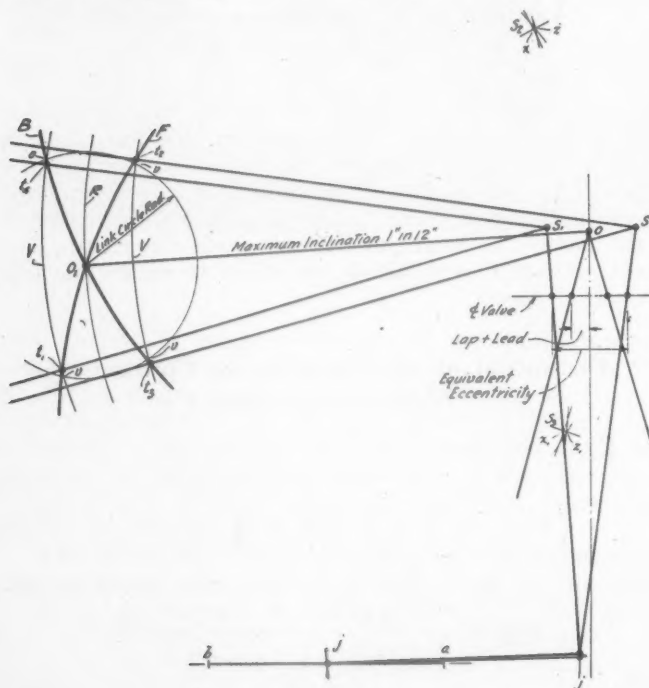


Fig. 10

With  $a$  and  $b$  as centers and the length of the main rod as a radius, describe arcs  $\pi-\pi$  as indicated in Fig. 9. Connect  $O_2$  with  $a$  and  $b$ , intersecting stroke circle at  $e$  and  $d$ . Midway between  $e$  and  $d$  locate  $C$ , which is the forward dead-center position of the crank pin. From  $C$ , through  $O_2$ , draw a line intersecting the stroke circle at  $C_1$ , which is the back dead-center position. Points  $f$  and

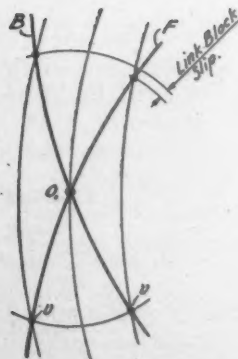


Fig. 11

$g$  are located midway between  $C$  and  $C_1$ . Then with  $f$  and  $g$  as centers and the length of the main rod as a radius, describe arcs  $h$  and  $i$ , locating point  $j$  on the crosshead path. When the point of intersection of arcs  $h$  and  $i$  is off the center of the cylinder, it indicates that, for the length of main rod selected, the height of the center of the cylinder above the axle center is not correct. This should be corrected, if conditions permit, before continuing with the design.

### Locating Link Positions

By locating the bottom connection of the combination lever in Fig. 10, from position  $j$  as found in Fig. 9, and the valve stem locations according to the equivalent eccentricity, positions  $s$  and  $s_1$  can be established.

From  $O$  describe arc  $R$  with the length of the radius bar  $OR$  as a radius; also from  $S$  and  $S_1$  describe arcs  $V$  cutting the link circle at points  $v$ . From points  $O_1$  and  $v$  describe arcs at  $S_2$  and  $S_3$ . Join  $O_1Z$  and  $O_1Z_1$  to locate points  $x$  and  $x_1$ . With the same radius  $OR$ , describe from  $x$  and  $x_1$  arcs  $F$  and  $B$ , which intersect arcs  $V$  at  $t_1, t_2, t_3$  and  $t_4$ , the actual positions of the link block at extreme link throw. This method divides up the link-block slip between forward and backward motion.

In the case of passenger locomotives it is sometimes desired to throw all the link-block slip into the back-up

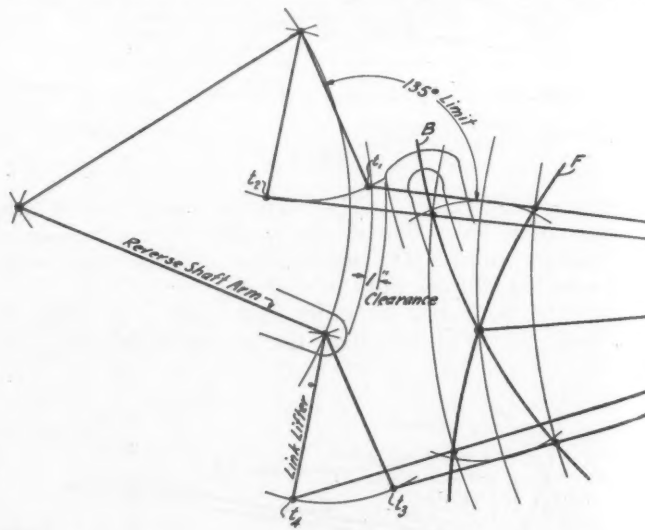


Fig. 12

motion. Then, as in Fig. 11, with  $O_1$  and  $v-v$  (in full gear forward) as centers, locate points  $x$  and  $x_1$  as centers of the link radius.  $F$  and  $B$  will then represent the positions of the link in extreme positions.

### Locating the Reverse Shaft

While the conditions of the locomotive may require that the slip-block style of shifter be used, the recommended link connection attached to the radius bar beyond the link block will be described here.

By assuming a length  $Ft_1$  and locating points  $t_2, t_3$  and  $t_4$ , as shown in Fig. 12, the center of the reverse shaft can be located. Care should be taken that the angle between the link lifter link and the radius rod does not exceed 135 deg. in extreme positions, and that the reverse shaft arm clears the link in its extreme position by at least 1 in.

### Locating the Eccentric Crank and Eccentric Rod

With the crank pin positions  $C, C_1, f$  and  $g$  as in Fig. 9, and the link positions  $R, F$  and  $B$  as in Figs. 10 or 11, assume, tentatively, a link tail radius  $L$  and offset  $T$

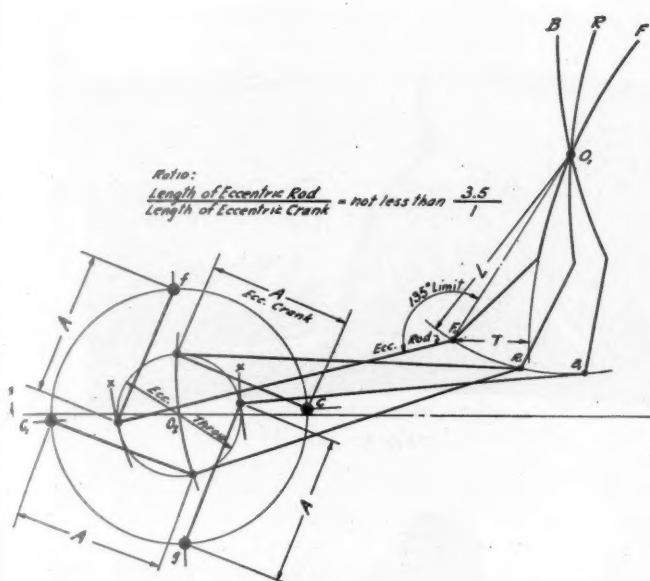


Fig. 13

which will locate points  $R_1$ ,  $F_1$  and  $B_1$ . With  $R_1O_2$  as a radius, describe arcs  $x-x$  as shown in Fig. 13. If the link tail offset  $T$  is correct, arcs  $x-x$  will be equidis-

tant from  $O_2$  so that an eccentric throw circle may be drawn with  $O_2$  as a center. Then if, with  $F_1$  and  $B_1$  as centers and  $R_1O_2$  as a radius, the eccentric throw circle will be intersected at points which are the same distance  $A$  from  $C$  and  $C_1$ , then the elements shown are correct. It will be noted that it is usually necessary to make several trial layouts, assuming different values of  $L$ ,  $T$ , and  $R_1O_2$ , before eccentric crank  $A$  will check out in all four positions.

Care should be taken to see that the angle between the link tail and the eccentric rod in the extreme position does not exceed 135 deg. Also, the ratio of the length of the eccentric rod to the length of the eccentric crank should not be less than 3.5 to 1.

By laying out the valve gear as described, very little adjustment in the shop will be necessary. All the elements have been laid out with particular reference to their independent functions and if it is desired to plot the gear layout in several positions of the stroke, the total valve travel, valve events and valve positions with respect to the crosshead positions, will be found to hold very accurately to the values determined in advance by means of the Zeuner diagram and the theoretical valve ellipse. For this reason, it is seldom necessary to entail the extra work of actually plotting the ellipse from the layout or even setting up the gear on a model in order to take the valve events and the valve ellipse readings.

(To be continued)

## Failures of

# Locomotive Parts\*

By F. H. Williams†

LOCOMOTIVE tires fail because of defects in the steel chargeable to the manufacturer, as well as because of rough machine work in the railroad shops. The latter type of defect was considered in the *Railway Mechanical Engineer* for July, page 314. The present article will deal with manufacturers' defects.

It is comparatively easy to distinguish between a failure caused by a defect in the steel and one caused by rough machining. It is not always an easy matter, however, to convince the one who is at fault that he is responsible. With rough boring and evidence of a fatigue crack starting from the bore, it is, of course, useless to attempt to prove that the manufacturer is to blame. There may be a manufacturer's defect in the same place that the fatigue crack started, but it is usually so insignificant in appearance compared with the rough machine work that the cause of the failure must be ascribed to the latter.

It is necessary, when a broken tire is to be examined by the metallurgist, that all of the fractured ends be sent to the laboratory, so that he can have a clear picture of what happened. Ordinarily a critical examination of all of the breaks will reveal the location of the first one. While the other breaks will, of course, be examined and reported upon, the primary break will receive the greater amount of attention and naturally will carry the onus of the failure.

## Break Caused by Defective Material

In the first example which will be considered in this article, only one of the six pieces into which the tire broke was at first shipped in. Had the cause of the break been based on this one piece, the failure would have been charged to rough boring. After a careful examination of the single part there was some question as to whether the particular fracture was the primary break. The other parts of the tire were sent for and an examination of the 12 ends revealed the part that was the first to fail. A detailed progressive examination was then made of the two surfaces of the fracture and the report was based on this break.

A fracture from a defect in the steel will usually be indicated within the broken section of the tire, while a fracture from rough machine work will start from the surface. This particular tire failed from a defect in the steel, which appeared in the fracture as a straight crack  $1\frac{1}{2}$  in. in width, parallel with the tread, and starting  $\frac{5}{8}$  in. from the outer face of the tire. This crack is shown in Fig. 1; the dark area directly above the crack is the shadow of the overhanging fracture and has no particular significance.

Examination of the fracture revealed a narrow band about  $\frac{1}{8}$  in. deep under the crack. This is part of the fatigue crack, transverse to the major portion, which is parallel to the surface of the tread, and the tire failed when the crack turned downwards and across the section. As long as it ran parallel to the tread, the tire

\* Part 4 of an article which began in the May issue.  
† Assistant Test Engineer, Canadian National Railways.



FIG. 1



FIG. 5

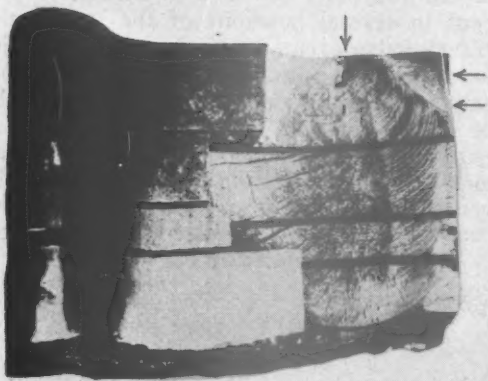


FIG. 2

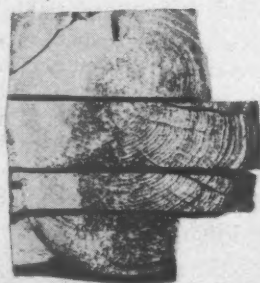


FIG. 3

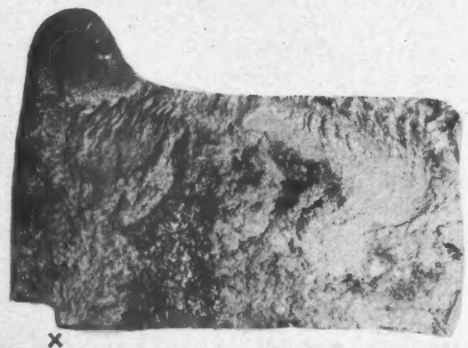


FIG. 5A

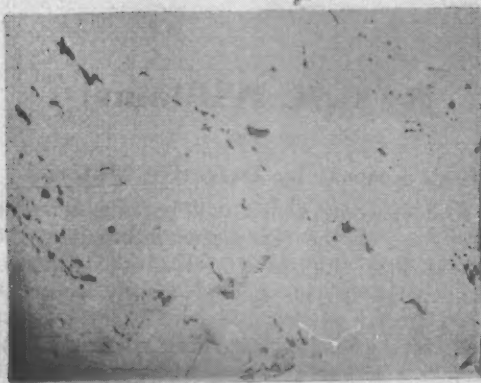


FIG. 4

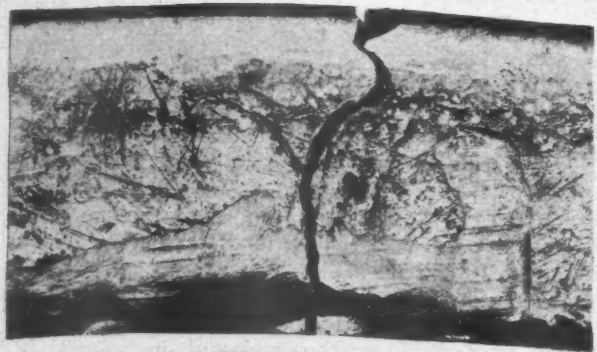


FIG. 7

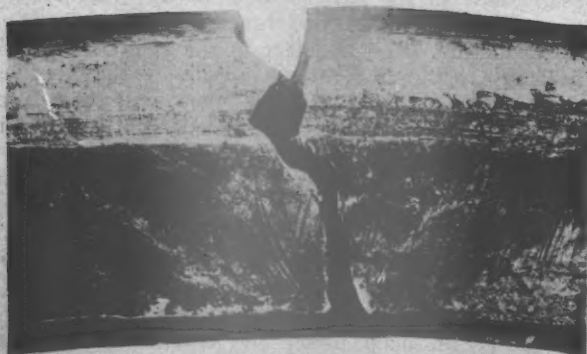


FIG. 6



FIG. 7A

remained intact, although the surface of the crack may have been several square inches in area; as a matter of fact, this actually proved to be the case when the fatigue crack was opened up to view.

Looking at the long crack in the fractured end of the tire, as shown in Fig. 1, the verdict in general was that the tire was piped and that it failed because of this. A pipe would hardly occur in such a location and in that shape, however, and it was decided to make a more detailed study of the fracture.

Several slots were cut through the tire parallel to the fracture, the sections varying in width from  $\frac{1}{2}$  in. to an inch. These were then cut crosswise as shown in Fig. 2, so that the pieces could be removed and the crack opened up to view. The mate to this face is shown in Fig. 3. As each slice was cut and examined, the picture began to clear up and the pipe faded into a fatigue crack of unusual proportions; the cutting continued until the nucleus was disclosed and the cause clearly developed. The defect is indicated by the dark line near the top of the view in Fig. 2; this was about  $\frac{1}{4}$  in. in length and a short distance below was a second defect shown by a dark spot about  $\frac{1}{16}$  in. long.

#### Macrostructure Examination

A section of the tire was then cut, polished and deep etched, with the result that a small area at the nucleus of the defect was eaten out by the acid. This area, more porous than the main part of the section, was in the deep etched part which appeared to be free of any defects. This small area was just in line with the flaw shown in Figs. 2 and 3 and is an indication of the source of the failure. Incidentally, this case is similar to a number of others where failures under the drop test were chargeable to such defects.

#### Microscopic Examination

Continuing the study, a specimen was cut for examination under the microscope; it included the area which showed up as defective in the deep etched section. This unetched specimen showed that the steel in the defective area was full of inclusions. A microphotograph is shown in Fig. 4. The defects appear to be sulphides and when the surface was deep etched they were eaten out, leaving the section porous. This flock of sulphides was about  $\frac{1}{4}$  in. in length and  $\frac{1}{32}$  in. in width—a rather small defect in the steel, yet it was the cause of the failure of the tire.

#### Why Was It the Primary Break?

Why did we select this break as the primary cause of the failure? Examining the tire in general we found that

it had been slightly warped and was not true. To remedy this the shops faced off a portion on one side, and rather roughly at that; about two-thirds of the surface on the flange side showed evidences of removal of material in this way.

The tire in question broke into six pieces and it was, of course, advisable, if possible, to study the break which opened up first. In our studies of tire failures over the past ten years or so we have had many instances where there was only a single break. When a tire fails in this way the fracture is usually practically in a straight line, starting from the bore and at right angles to a tangent to the circle at the point from which the break starts. In many instances the fracture forms a right angle with this tangent for the full thickness of the tire.

Simple examples of such breaks will be found in tires broken in the course of shipment. Recently I noticed a tire that failed, which was shrunk on the wheel center just before the shops closed down for the holidays. The men on returning to work after the holiday season discovered the tire broken. The fracture was perfectly straight across the section, starting from a torn sharp edge—otherwise the tire was perfect. Based on many instances of this kind, we have concluded that when a tire breaks into several pieces, generally speaking that fracture which is straightest across the full section of the tire is the primary break.

Let us now consider the other extreme—the case where the tire fails with an irregular break, although it started with a fracture that for an inch or two was similar to the lines of the primary break. In other words, the fracture starts out exactly like that of a primary break and then flares out on either one side or the other. One of the tests required before a shipment of tires leaves the mill is the drop test. It is not unusual for a tire to fail under such a test, in which case the breaks are similar to those just mentioned, whether the failure starts from tool marks caused by rough machining, or defects in the steel. The manufacturers are careful to protect the tires from failures by taking pains to remove all sharp edges by rounding them off, and by using fillets rather than making sharp corners.

The illustrations with this article attempt to show the difference between primary and secondary fractures and represent average failures of each type. It is not intended to convey the impression that all failures of either type will be similar. There are, of course, departures from the average and in such cases critical investigations must be made in the attempt to determine which is the primary fracture. Most of the failures, however, come fairly close to the typical types described above, the primary fracture being a straight break across the section and the secondary fractures starting off in a straight line for a short distance, and then flaring out.

With this background, let us examine the four fractures in the tire which are illustrated by Figs. 5, 6, 7, and 8. These are all views looking toward the flange side of the tire. All of the fractures except the one illustrated in Fig. 8, show the break deviating from a straight line, about one inch from the bore. It is, therefore, fair to assume that the break shown in Fig. 8 was the primary cause of failure. The others (Fig. 5, 6, and 7) are typical fractures for a tire failing under the drop test; that is, of a tire that has been crushed by pressure. We, of course, do not know the exact sequence of the secondary failures. They may have been the result of blows only, or a combination of blows with defects in the steel or rough machine work. In this particular case we decided that they were mostly the result of blows and rough machining, the latter being started small fatigue cracks, which in time would have resulted in a complete fracture.

Fig. 1—Primary fracture, showing crack parallel to tread. Fig. 2—Tread of tire cut away to show the face of the transverse fatigue crack. The two dark spots in the upper right-hand corner, and in line with the arrows, are defects which caused the failure; in other words, they are the nuclei of the fatigue crack. Fig. 3—The opposite face of the fatigue crack shown in Fig. 2. Fig. 4—A micro-photograph showing defects which caused the failure. Fig. 5—Side view of tire, which was faced off because of warping. This is one of the secondary fractures. Fig. 5a—Cross section of break shown in Fig. 5. Note the fatigue crack at X. Fig. 6—Another side view of the tire, showing rough facing. This is another secondary fracture. Fig. 7—Another side view of the tire. No metal was removed at this point in the facing process. This is another secondary fracture, the break starting at the bore, as in Figs. 5 and 6. Fig. 7a—Cross section of the break shown in Fig. 7. The fatigue crack started at X, at the edge of the counterbore.



FIG. 8



FIG. 9



FIG. 10

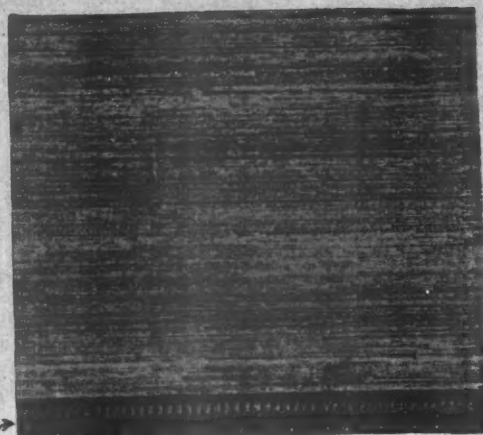


FIG. 11

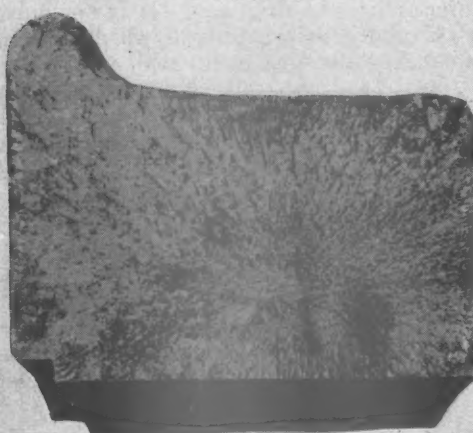


FIG. 12



FIG. 12A



FIG. 12B

FLANGE

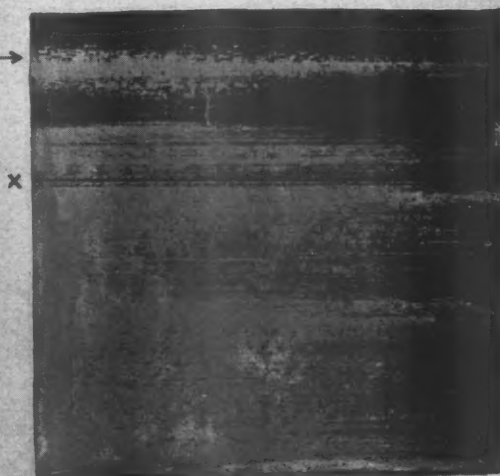


FIG. 14

Figs. 9 and 10 show where the fatigue crack splits the tire and comes to the surface of the tread. Fig. 9 is a side view; the crack extended about six inches lengthwise of the tread from the fracture, the cross section of which is shown in Fig. 1. Fig. 10 is a view looking down on the tread of the tire. The crack is shown extending lengthwise near the right-hand side and also crosswise for most of the width of the tire.

It so happens that fatigue cracks are quite evident in two of the fractures, Figs. 5a and 7a, in one case at the edge of the bore and in another at the edge of the counterbore, both on the flange side of the tire. Both photographs show fairly clearly the lines of fracture radiating from the fatigue crack. These started from roughnesses caused by the boring and counterboring of the tire (see Fig. 11). Had the tire not failed because of the flaw in the steel, it would undoubtedly have done so later on,

Fig. 8—Primary fracture at the left. Note that it is fairly straight and almost at right angles to the bore.  
 Fig. 9—Looking at the side of the tire with the flange at the far side. The crack will be seen extending lengthwise along the tread, in line with the arrow.  
 Fig. 10—View looking down on the tread of the tire, showing where the primary crack had come to the surface. For side view see Fig. 9. The crack shows quite clearly near the right side, but it actually extends in line with the arrow, almost to the dark portion at the left.  
 Fig. 11—Note the rough machine work in the boring of the tire, and particularly in the counterbore.  
 Fig. 12—Fracture caused by defective steel. Nucleus of the fracture at about the point where lines projected from the arrows would meet.  
 Fig. 12a—Opposite face of fracture shown in Fig. 12.  
 Fig. 12b—The deeply etched section reveals the defect at the nucleus of the fracture. It is at a point where lines extended from the two arrows would cross.  
 Fig. 14—Example of a poorly turned tire. Note the rough tooling on the flange and near the throat of the flange at X.

because of these fatigue cracks. This emphasizes the fact that it is essential not only that the very best steel be used, but that every precaution be taken to insure a smooth job of machining.

#### Another Failure

Let us now consider another tire failure caused by a defect in the steel. This particular tire failed a little over a month after it was placed in service, new. In this case the tire was not broken into pieces, but a single break opened up. There is, therefore, no question about the primary break. Figs. 12 and 12a show the two faces of the fracture. The nucleus of the break, as indicated by the point from which sunburst radiations extend, was about  $1\frac{1}{4}$  in. from the bore and two inches from the outer edge of the tire. There is in this instance really no definite fatigue crack; that the crack is progressive is indicated by the finer structure near the nucleus, the fracture gradually becoming coarser the farther it gets from the nucleus.

In the macrostructure examination, Fig. 12b, the deep etched section reveals the porous spot, about  $\frac{1}{4}$  in. by  $\frac{1}{2}$  in. in size, situated in about the same location as the nucleus of the fracture. Fig. 13 shows the bore of the tire. It is very rough and had it not been for the defect in the steel, would in all probability have caused a fracture of the tire later on. A rough machining job was also done on the tread of the tire, as is indicated by Fig. 14. The metal was gouged out on the throat and torn on the flange.

These are only two instances of fractures, but they are typical of others. Usually an examination of a deep

etched section reveals the fault to be in approximately the same location as the nucleus of the fracture, provided the section for examination is cut within a reasonable distance either side of the fracture.

#### Locomotive Wheel Centers

There is another matter that should be given consideration and that is the effect of the wheel center being out-of-round. Steel tires endure hard service, but if the tire is not in any way defective, its shrinking on a

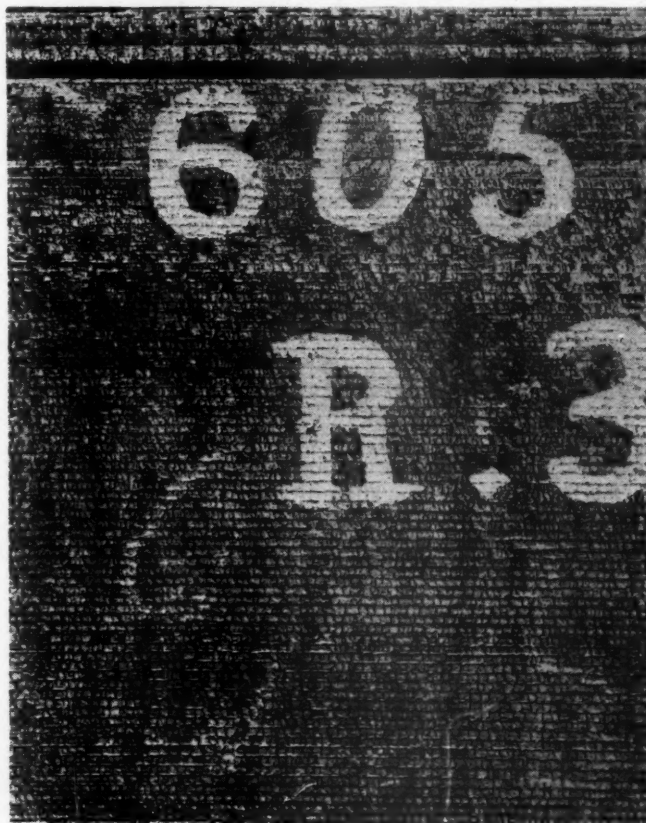


Fig. 13—Rough machine work on bore of tire

wheel center out-of-round will not necessarily cause a failure. The thing that causes failure is not excessive stresses on the tire due to service, or the lack of contact with the wheel center, or an out-of-round wheel center. Rather, it is the finish of the surface of the tire and the quality of the steel, both of which must be as nearly perfect as possible. We are careful to provide test pieces of tire steel which are finished with a high polish, and yet the tires are expected to stand up in service with surfaces almost as rough as alligator skin.

Might it not be advisable to consider the possibility of using nickel cast iron of reasonably high strength for wheel centers on locomotives? This may appear to be too daring a suggestion, but let us consider it. The damping effect of cast iron is much greater than that of steel, about 25 times as much. When a tire suffers from a blow, the shock is transmitted to the axle and may cause an axle failure. Passenger car tires are placed on cast iron wheel centers. I do not know of a broken axle that can be ascribed to failure in the wheel fit in passenger car service. They fail outside the wheel centers, but not inside the wheel fit. On locomotive axles about 50 per cent of the failures start in the wheel fit. If nickel cast iron of 55,000-lb. tensile strength is used it will be necessary to alter the design of the wheel center considerably, but there should be a saving in both axles and tires.

# Corrosion of Open-Top Cars

By **G. N. Schramm\***, **E. S. Taylerson†**, and **C. P. Larrabee‡**

**FOUR** principal factors other than mechanical damage are responsible for the destruction of hopper cars and gondolas: (1) Atmospheric corrosion; (2) corrosion due primarily to the character of the lading; (3) schedule or method of operation of the cars as affecting the amount of atmospheric and lading corrosion, and (4) abrasion. The first three factors depend upon the three principal types of corrosion: Atmospheric, under-water and chemical corrosion.

It has been established<sup>1</sup> that the amount of corrosion of a steel structure in the atmosphere depends primarily on the amount of atmospheric pollution, on the length of time the structure remains wet, and on the amount of wet, solid foreign matter, such as dust or soot, which remains in contact with the structure. The rate of corrosion may be further influenced by the angle of slope of the structure, by the smoothness and tightness of joints, by the adherence of the scale or rust film which forms, by the acidity or alkalinity of the polluting liquids, and by the degree of roughness of the surface of the steel. The composition of the steel has an important bearing on the rate at which it corrodes, hence the adoption first of copper steel and now the widespread and increasing use of Cor-Ten.

Because the corrosion of steel, and of other metals, depends upon the exact conditions which surround its use—conditions which determine the kind of corroding mechanism and the rate of corrosion—it is essential to consider the conditions which may exist during the use of a particular type of car. The service to which a hopper car is subjected, for example, may vary from trip to trip, or even from time to time during the same trip. The identification of the causes of corrosion under these complicated conditions is not a simple task, but the determination of the causes when the structure is under the same conditions throughout its serviceable life may provide a basis for the estimation of the amount of corrosion under complicated conditions. If this appears impossible, such a consideration will at least facilitate the estimation of the durability of different kinds of steel under identical conditions.

Open-top cars are used for the transportation and storage of coal, coke, cinders, sand, stone, etc., some of which are more corrosive to the cars than others. Severe corrosion cannot take place, however, when the car sides and bottoms are covered by these commodities, unless the lading is wet. If the lading is wet when loaded or becomes wet from rainfall, then local corrosion may be initiated and rusting will proceed at a rate which depends on the character of the leachings which filter through the lading, and also on the temperature. The leachings may vary widely in their properties; those coming from coal and cinders, for example, are much more destructive than water leachings from sand and stone.

**A critical study of causes discloses that 80 per cent or more of the deterioration is due to atmospheric corrosion and that the effects of leachings do not become severely destructive until bituminous coal has been in cars from four to six weeks.**

Corrosion caused by atmospheric conditions and by leachings from lading may be affected by the schedule of operation of car equipment. Cars which are stored under certain types of loads for weeks at a time or even months, may be impaired by corrosive leachings, whereas cars which are stored empty, for long periods of time, are subjected to the relatively mild atmospheric type of corrosion. Cars operating in normal service are, of course, subjected to both atmospheric and some degree of lading corrosion, but the latter will not prove serious except in those cases where, due to faulty design, particles of lading are trapped in seams or pockets.

## Atmospheric Corrosion

The corrosion of steel cars is due primarily to exposure to atmospheric conditions. The Freight Traffic Report of the Federal Coordinator of Transportation<sup>2</sup> shows that the average period from the time freight cars were placed for lading until released by consignee was 6¼ days for gondola and hopper cars. Other statistics show that in 1930 the number of carloads of freight carried in hopper and gondola cars was approximately 14,219,000, and the total number of hopper and gondola cars, railroad and private, was 947,724. This would require an average of 15 trips per year by each hopper or gondola car. Since chemical action stops when the lading freezes and since freezing temperatures prevail in the Middle Atlantic States and other Northern states during approximately one-fourth of the year, the average number of trips during which a car may be exposed to lading corrosion is correspondingly reduced to 11¼. Further, since rain falls during approximately one-third of the days of the remaining nine months, it may be estimated that lading will become wet after a lapse of one-third of the average number of days during which it is under load. If it is assumed that the car is under load during the 6.25 days from the time it is placed until it is released, although 4.7 days is probably more accurate, the lading will probably be subject to rainfall after 2.08 days. The lading will probably be wet during the remainder of the trip, if average precipitation is heavy enough to saturate the contents, and the average period during which the car is susceptible to lading corrosion is then two-thirds of the time it is loaded, or an average of

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<sup>1</sup> The Influence of Rainfall and Smoke on the Corrosion of Iron and Steel, by G. N. Schramm and E. S. Taylerson, Symposium on the Outdoor Weathering of Metals and Metal Coatings, American Society for Testing Materials, 1934.

<sup>2</sup> Freight Traffic Report, Section of Transportation Service, Federal Coordinator of Transportation, Volume 1, page 88.

4.17 days per trip, or, on the basis of 11.25 trips per year during non-freezing weather, 47 days a year. Of the 14,219,000 hopper and gondola carloads originated in 1930, only 6,024,963 were bituminous coal; that is, only 42.4 per cent of all hopper and gondola loads consisted of bituminous coal. Therefore, if a car is susceptible to corrosion by all kinds of wet lading during 47 days a year, it may be subjected to wet bituminous coal corrosion during an average of only 20 days a year.

These figures are rough approximations only and are subject to wide variation, but even if the period of susceptibility to bituminous coal corrosion is trebled (to 60 days) they indicate generally that coal, if loaded dry, can be the agent responsible for the corrosion of an open-top car, in average intermittent service, only over a very short period of time—a period probably too short to be extremely harmful. However, if the car is exposed to wet coal continuously for a single period of 60 days during the year, corrosive attack may be severe.

Since steel corrodes only when wet, coal or other lading retained in pockets or at joints in an open-top car increases corrosion by greatly prolonging the time the structure remains wet. Therefore, every attempt should be made to obtain complete removal, or the car so designed that a minimum of lading is retained in the car.

Examination of the corrosion products in the scale on the sheets of an old hopper car has shown them to be substantially the same as the rust which forms on steel that has been exposed only to atmospheric conditions. There is no evidence to indicate that this rust was formed by any means other than atmospheric conditions. The amount of sulphur (sulphate), for example, in scale removed from five hopper cars of widely different age and service was 0.18, 0.22, 0.35, 0.25 and 0.41 per cent, while the sulphate sulphur from corrosion products which formed on copper steel exposed only to an industrial atmosphere was slightly greater than any of these figures—0.45 per cent.

The destruction of hopper cars by coal is probably greatly over-emphasized, much of the deterioration by other corrosive conditions being held to be due to coal. It has been said that hopper cars have been destroyed within six months by the leachings from soft coal. As previously stated, "The very fact that some of these cases have been recounted on several occasions demonstrates the unusualness of the phenomenon, but the most striking proof that these are unusual cases rests on the fact that the hundreds of thousands of cars in normal service have not been affected by such severe corrosion in a short time."<sup>3</sup> It is probable that the cases which have commanded attention involved cars which had already received considerable service before being subjected to long-time storage.

If it is accepted that atmospheric corrosion, lading corrosion, the schedule of car operations, and abrasion are responsible for the destruction of cars, attention may be given to the methods of combatting such destruction. The schedule of car operations should provide for full and empty service without long periods of storage under load, particularly of coal and cinders. The character of the lading cannot be changed, but cars should be unloaded promptly.

#### Low-Alloy High-Strength Steels

Atmospheric conditions cannot be changed, but steels which are more resistant to severe industrial atmospheres than mild or copper steels can be and are being used extensively to provide equipment which is more

durable than that constructed of the usual steels. As described by Whetzel,<sup>4</sup> corrosion-resistant high-tensile steels are being used by many railroads to combat the problems arising from the rapid destruction of ordinary steel equipment. The composition and physical properties of Cor-Ten, the most widely used steel of this type, have been described elsewhere.<sup>5</sup>

#### Coal Corrosion

The corrosion of steel cars by coal depends largely on the kind of coal, and the length of time coal is stored in a wet condition in the cars. Long storage permits two corrosion mechanisms to act on metal parts: (1) Attack by leachings which contain appreciable amounts of ferric sulphate, and (2) corrosion set up by the constant physical contact of particles of wet coal against the metal sides and bottoms.

Solid particles in constant contact with metals which

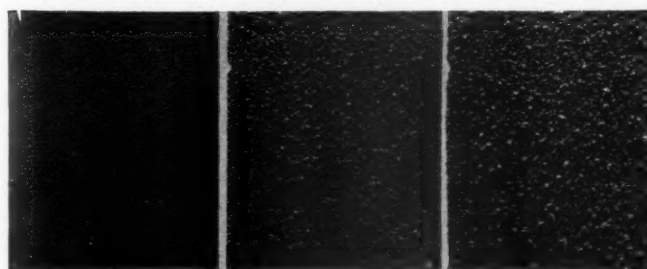


Fig. 1—Rusted samples of Cor-Ten (left), copper steel (center), and plain steel (right) after three years in an industrial atmosphere

are continually wet, produce oxygen concentration cells or salt concentration cells in which the concentration of either salt or oxygen dissolved in the water under the particle differs from that in the water adjacent to the particle. This difference in concentration results in local electrolytic or battery action and causes and promotes corrosion of the metal under the particle.

These two forms of destruction—attack by leachings and attack by particle contact—react on nearly all metals and are not to be construed as pertaining to steel alone. Contact corrosion may also result from the contact of other kinds of wet particles, such as sand or stone, against metal surfaces, but in the case of stored coal, ferric-sulphate corrosion conceivably may proceed without contact corrosion. The size of the material of which the lading is composed has also an important influence on the extent of contact corrosion and on the length of time the lading remains wet. Lading consisting of material of small size may produce a greater amount of corrosion.

Several tests have been made to determine the rate of corrosion of different kinds of steel by wet coal. In cooperation with one of the eastern railroads, clean (pickled) pieces of different steels were fastened to the bottoms and sides of hopper cars which were subsequently loaded with coal and the coal wet with sufficient water to cause a small, but continuous flow of leachings. The cars were kept under load for a period of six months. A careful study of the results of this test shows that it would be necessary to subject a scale-free hopper car to ten periods of similarly severe corrosion to dissolve completely the sides and bottoms. It is estimated, however, that perforation of the plates or sheets caused by pitting would be extensive enough to require replacement of the sheets after not more than five such periods of exposure. Under the most severe

<sup>4</sup> Modern Steels and Weight Reduction, by J. C. Whetzel. American Iron and Steel Institute, May 23, 1935.

<sup>5</sup> New Alloy Steels and Their Application to Car Equipment, by G. N. Schramm, E. S. Taylerson, and A. F. Stuebing, Railway Age, December 8, 1934, page 761.

conditions as represented by a test of this kind, in which pickled sheets were subjected to continuously wet coal, the car body might require replacement in approximately 2½ years. The plates in the bodies of conventional hopper and gondola cars remain serviceable for approximately 9 to 12 years, the exact length of time varying with the kind of steel and the particular service conditions. Destruction of the plates by the severe corrosion induced by stored wet coal for repeated periods of six months' duration may occur; therefore, in only approximately one-fifth of the time of average car "life."

In another test made by a mid-western railroad two hopper cars, one constructed of Cor-Ten and the other of copper steel, were allowed to stand loaded for six months with two sizes of coal containing 2.5 per cent sulphur. The decrease in thickness of the plates in different parts of the cars was measured by a micrometer. The average loss in thickness was 0.0014 in. for

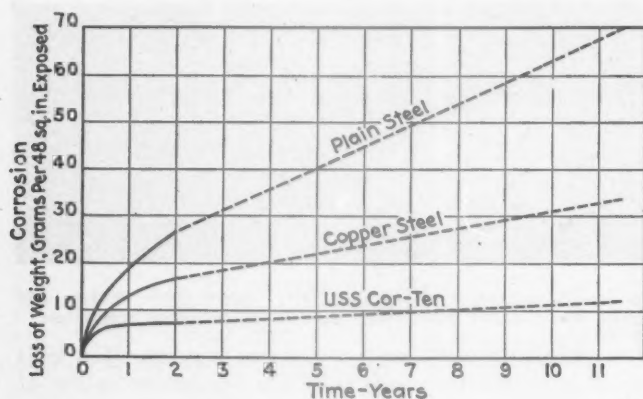


Fig. 2—The relative corrosion resistance of Cor-Ten, copper steel and plain steel in an industrial atmosphere

the Cor-Ten car and 0.0030 in. for the copper-steel car. The largest loss in thickness occurred in that part of the car containing coal screenings, the loss being 0.0037 in. for Cor-Ten and 0.0072 in. for the copper steel. This would indicate that under the most severe conditions the plate would be completely destroyed in from 67 to 35 such storage periods, depending upon the kind of steel used in the construction of the car. Perforation at local points of attack would occur very much sooner, such perforation necessitating the removal of the car from service. These results are as nearly concordant with those obtained on the eastern railroad as could be expected under the radically different conditions of the two tests.

To estimate the proportion of corrosive action in freight cars which is due to coal leachings, several factors must be considered. As demonstrated above, the average exposure to leachings from wet coal during non-freezing weather is only 4.77 periods of 4.17 days in each year. As will be shown later, the corrosive action set up in the first month of storage, even with coal high in sulphur, is only one-thirtieth as severe as the average corrosive action for the first six months of storage due to the fact that a period of approximately one month is required for the formation of severely corrosive leachings. Many coals have low sulphur content and the leachings which form from such coals may be only mildly corrosive. In normal coal-car service the interval between exposure to coal permits the formation of a rust film which serves as a partial protection against the action of the leachings. When cars are loaded and emptied frequently contact corrosion is distributed more uniformly over the plates and does not cause such severe local pitting as occurs when coal

remains stationary in a car for a long period.

During the normal life of the plates in open-top cars, a period of about 12 years, coal corrosion may act for an average of 4.77 periods of 4.17 days each year, or 57 periods of 4.17 days in 12 years. Provided no periods of exposure to leachings are over one month, the corrosive action due to wet coal during the entire 12 years would be equivalent to only about one-thirtieth of one period of six months under continuously wet lading. Even if it is assumed that the coal is so corrosive that it would perforate the plates in six months if stored, the effect of coal leachings in normal service would account for the loss of only about one-thirtieth or less than 4 per cent of the plate. If the car is in coal service exclusively, the corrosion attributable to coal leachings would not normally cause the loss of more than 10 per cent of the plate. The other 90 per cent of the deterioration must necessarily be ascribed to other corrosive agents or mechanical damage.

It appears logical to believe that this major destruction is brought about by exposure to the atmosphere and that the fundamental method of obtaining greater serviceability is to construct the cars of a steel that is more resistant to atmospheric corrosion than copper steel. Those low-alloy high-tensile steels which are actually two to three times more resistant to severe industrial atmospheres than copper steel will provide much greater serviceability.

Tests carried out by storing wet coal in hopper cars produce conditions which are radically different from those which usually exist and, since service conditions must be duplicated in order to determine the relative serviceability of different materials of construction, it follows that such tests are of questionable value. Hopper cars loaded with wet coal for test purposes will reveal only what may happen to cars when they are used for storage purposes and not what will happen in regular or normal service.

### Protective Rust Films

Laboratory tests show that freshly pickled samples of steel corrode in ferric-sulphate leachings many times faster than samples which have a rust film on them. Samples of steel carrying a rust film which was formed by exposure to an industrial atmosphere for one and one-half years dissolved at a very much lower rate than freshly cleaned samples of the same steel when both were immersed in the corrosive ferric-sulphate leachings from wet coal. The difference in rate of corrosion of freshly cleaned pieces and of samples which carried a rust film is due to the protective influence of rust films. That the rust films shown in Fig. 1, which were formed in an industrial atmosphere, are protective is demonstrated by the shape of the curves shown in Fig. 2. If the films had not been protective, straight lines, showing a constant rate of corrosion, would have been obtained. It is seen, however, that the rate decreases with time, even in the case of plain steel. The extreme flatness of the Cor-Ten curve is due to the dense, hard, and adherent rust film on that material which is especially protective. This does not mean that a point is not ultimately reached at which the rate is constant, as it appears logical to believe that a rust film can be protective to only a certain extent.

A thorough test of 15 freshly pickled steels and the same number of rusted steels of identical composition buried in wet coal for a period of five months indicated that the samples having the rust films were about 42 per cent more resistant than the cleaned samples. The rust film was formed originally by exposing the pieces to a severe industrial atmosphere for one year. The pronounced difference in behavior of steel when buried

in wet coal and when immersed in the leachings which filtered from the same coal indicates the extreme sensitivity of corrosion tests and the necessity for duplicating service conditions exactly if pertinent data are to be obtained. The protection of steels in the atmosphere, under wet coal and in ferric-sulphate leachings by an oxide, however, indicates that the rust film has an important bearing on the serviceability of steel cars.

### The Nature of Coal Leachings

The corrosiveness of coal leachings is due to the ferric sulphate that is formed by the action of air and water on sulphur minerals in the coal. The chemical reactions by which this compound is formed from the iron sulphide in the coal, present as both pyrite and marcasite, are very complex. The factors that favor the formation of corrosive leachings are free access of air



Fig. 3—Stainless-steel equipment for the study of the leachings from wet bituminous coal—The depth of the cylinder is equivalent to the average depth of coal in a hopper car

and water, fineness of the coal, amount of iron sulphide in the coal and high temperature. The last factor is very important since chemical reactions of this nature generally double their rates for each increase of approximately 20 deg. F. When ferric sulphate attacks steel or iron the product is ferrous sulphate which is an intermediate product in the oxidation of the iron sulphide to ferric sulphate. Therefore, in the case of stored coal in iron containers once the action starts it is self-accelerating until the products are washed out by heavy rainfall. Laboratory tests have shown that a comparatively weak solution of ferric sulphate is more corrosive to steel, but not to rust, than equally weak solutions of sulphuric acid.

In order to determine experimentally the rate of the chemical reactions which take place when bituminous coal remains wet for long periods of time, the stainless-steel cylinder shown in Fig. 3 was filled with thoroughly wet run-of-mine bituminous coal from which lumps over 4 in. in diameter had been removed. Ob-

viously a plain steel container, or even a hopper car, cannot be used for this kind of test, because the leachings react with the steel before they can be collected and analyzed. The filtrate or leachings were collected in bottles suspended at the opening in the conical bottom of the cylinder. The top of the cylinder was covered in such a manner as to exclude dust but not air. It was kept in a warm boiler house throughout the test. The coal was wet twice weekly with distilled water in amounts equivalent to normal rainfall, and the collected leachings were analyzed.

The curve in Fig. 4 shows graphically the results of the test. The amount of ferric sulphate in solution did not begin to become appreciable until the coal had been in storage from four to six weeks, after which it increased rapidly, reaching a maximum after about three months. The concentration then began to fall and at the end of a year it was approximately the same as it was after only six weeks of storage. At no time during the test was sulphuric acid or ferrous sulphate found in appreciable quantities.

These data indicate that coal should not be stored wet in a hopper car for a period of time exceeding four to six weeks. Obviously this period will vary with the kind and size of coal and whether it is bituminous or anthracite and on the prevailing temperature during the storage period. Corrosion practically stops when freezing starts, and the rate is very low near freezing temperatures. This means, of course, that railroad equipment does not corrode as fast in cold weather as it does during the warm months of the year. Very hard rain storms will produce a flushing action which will cause the immediate removal of the accumulated sulphur compounds without permitting the ferric sulphate to react with the steel. This flushing action

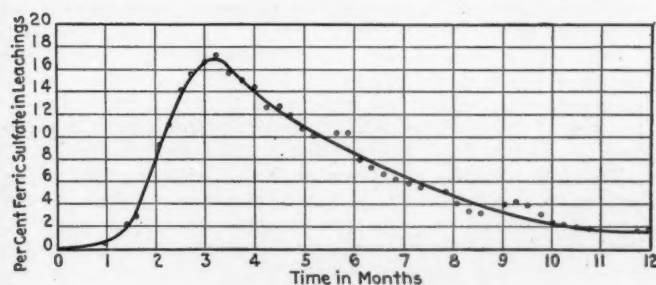


Fig. 4—The effect of time on the concentration of destructive iron compounds which leach from wet coal

will tend to increase the period of time before the leachings begin to corrode the car.

### Abrasion

Tests carried out by exposing samples of several steels to the abrasive action of coke show that Cor-Ten is approximately 40 per cent more resistant to abrasion than mild steel or copper steel. These tests were made by fastening, into coke chutes, large samples of different steels which had been pickled. The resistance of this steel to abrasion is another factor which will assist in providing greater serviceability for those cars which carry abrasive loads.

Light-weight cars constructed of Cor-Ten are now in operation on a number of railroads. Examination of these cars after intensive, assigned coal and coke service, shows them to be in excellent condition. The mill scale is gradually falling away and rust films are being formed. The rate of corrosion of corresponding copper-steel and mild-steel parts appears to be much greater than that of the high-strength steel.

## Considerations in Selecting Machine Tools

Few industrial organizations, whether engaged in production or transportation, have a more comprehensive and carefully developed program of machine tool replacement than the Westinghouse Electric & Manufacturing Company, if we may judge by a paper presented by L. D. Rigdon, director of equipment negotiations for this company, before the June meeting of the Machine Tool Electrification Forum at East Pittsburgh, Pa. In this paper, Mr. Rigdon explained the reasons why his company analyzes its individual machine tool requirements at the end of each year and makes a survey to determine just how many old tools are inadequate for one reason or another and how many and what types of new tools shall be bought to replace them.

Some of the questions which the Westinghouse organization asks itself in choosing a new tool and which may be of suggestive value to railway machine tool buyers are as follows:

Do we know from past experience that, while the machine looks good on paper, repair bills are high, and down time, due to repairs, is excessive with corresponding loss in production?

Do the manufacturers give service? That is, when difficulties arise in connection with the operation of their machine, do they have their representative call to make the necessary corrections in the shortest possible time?

Does the machine embody the latest improvements in design for that particular type of equipment?

Is the machine properly guarded so that a workman can operate it safely?

Is it advisable to purchase a duplicate of a machine we now have in use that goes into a line of similar machines in order to have interchangeable tool equipment and to enable us to switch operators from one machine to another without any loss in production?

Very often we send out drawings showing the piece to be machined and have the manufacturers submit quotations on the equipment they recommend, together with production estimates. In cases of this kind, we select the machine that gives the maximum production for the least amount of money expended.

The type of drive is also a factor in selecting the proper equipment in that we try to select machines to which motors have been applied so as to give the most economical operation. With the new cutting materials that have been developed in the last several years, speeds and feeds have been increased, and the type of drive will very often affect the range of these speeds and feeds; for example:—a machine driven by an adjustable speed d.c. motor or a multiple speed a.c. motor.

Is the tooling equipment on one machine easier to set up than on another? This is a very important item when dealing with machines that are used for short order work where pieces come through in small lots.

Are we justified in the purchase of a high-priced special high-production machine over a standard machine at a lower cost with a smaller production capacity? In such cases as this, a decision must be reached on the following points:

(a) Do we have sufficient production to keep the machine busy?

(b) Will the cost per piece be low enough to justify the additional cost of the special machine?

(c) Will the piece be in production a sufficient number of years to pay for the machine, as it will undoubtedly be obsolete and have to be scrapped if the piece is no longer manufactured.

(d) In case the design of the piece is changed, can the machine be changed over to manufacture a new design without involving a large expenditure of money?

(e) Is the company offering the machine reliable—that is, are they likely to be in business for a number of years so that equipment purchased from them can be duplicated and repair parts secured when necessary? This does not mean that the company has to be unusually large with respect to size, etc., but it must be well established, have good financial rating and have a personnel with the ability to keep the equipment up to date.

## Constant-Pressure Valve for Passenger Car Use

The Vapor Car Heating Company, Chicago, has recently developed a constant-pressure valve designed for use between high-pressure steam train lines on passenger cars and Vapor regulators which supply steam to the heating system. The purpose of this constant pressure valve is to maintain a uniform delivery of steam through Vapor regulators regardless of train-line pressures.

It eliminates excessive blow and waste of steam at the regulators, speeds up the passage of steam to the rear of long trains, and reduces wire drawing and wear of Vapor regulator inlet valve parts and at the same



Vapor No. 244 valve for use in maintaining uniform pressure in passenger-car steam-heating lines

time increases life of regulator diaphragms. Perhaps the most important function of this constant pressure valve is the fact that it prevents the necessity of readjusting the set screw of Vapor regulators to compensate for varying train-line pressures. In other words, passenger cars may be operated at either the head end or rear end of trains as desired without making any change in the set screw adjustments of any of the Vapor regulators in the train.

The Vapor constant-pressure valve No. 244 once applied requires no further attention—it automatically delivers steam to the regulator at a maximum of approximately 40 lb.

The valve is furnished with inlet and outlet union connections and is thus easily applied in the supply pipe between steam train line and regulator.

# Younger Men's Viewpoint

**Y**OUNGER men almost disappeared from the railroad ranks during the depression and only now, as conditions are improving, are they being recruited in any considerable numbers. It is high time that this is being done; moreover, special attention must be given to the training of these young men, for there promises to be a pressing need for skilled workers in the days ahead; indeed it is already beginning to be felt in some places.

From the ranks of these workers will come many supervisors. Because of the possibilities of radical changes in equipment design and of changed practices, it will be necessary for the worker of the future, and the supervisor and railway officer as well, to be much more thoroughly and carefully trained for his work than has been true in the past.

The *Railway Mechanical Engineer* is deeply concerned in the welfare of the young men who are now starting in at the bottom of the ladder. While this publication is designed to satisfy the needs of the officers and supervisors of the mechanical department, it is being read by a number of the more ambitious shop apprentices. With a view to finding out what use they were making of the paper—with the co-operation of M. H. Westbrook, shop superintendent of the Grand Trunk Western, at Battle Creek, Mich.—a little contest was staged, in which the apprentices at that point were asked to express, in a statement of about 250 words, how they expected to benefit by becoming regular readers of the *Railway Mechanical Engineer*.

Mr. Westbrook, who has always taken a keen personal interest in the apprentices in his shop and has encouraged them to read the technical publications, properly feels that they must have a reasonable amount of encouragement if they are to cultivate the habit of reading such papers and in understanding how to make the best use of them. Fifteen of the apprentices at Battle Creek commented upon the *Railway Mechanical Engineer*. Some of the high spots in their expressions follow.

## Ernest Nightingale

*Second Year Machinist Apprentice*

If one is to gain anything of value from reading a magazine regularly, the publication should have the following characteristics: First, it should have educational value. It should contain news, both technical and personal, of particular interest to those for whom the magazine is primarily intended. It should also be entertaining, to a certain degree, lest it become too dry and technical.

The *Railway Mechanical Engineer* fills these qualifications admirably well. The articles on technical subjects and those describing the tools and methods of shop practice on various roads are of special value to one engaged in learning locomotive or car maintenance. The editorials and discussions of laws pertaining to railway operation also contribute greatly to the educational value of the paper.

The descriptions of new equipment, and particularly the advertising section, keep one well informed on the latest developments in road and shop equipment. The Readers' page and the Gleanings from the Editor's Mail give a cross-section of thought from the average railroad men all over the country.

## Why they read technical publications, and what they look for

The element of entertainment is furnished in a manner that leaves very little to be desired by the Walt Wyre stories.

I shall, therefore, expect to gain a great deal and hope to become a better railway man for having become a regular reader of the *Railway Mechanical Engineer*.

## Robert W. McAllan

*Third Year Machinist Apprentice*

I find the *Railway Mechanical Engineer* very interesting and educational. The different departments of the magazine cover almost every repair job in the railroad shops. This is all very helpful to me, being an apprentice, as it brings to realization the problems that confront fellow workmen of different crafts. The section dealing with other shops is interesting, because I can compare their methods of doing a job, using different tools or machines, and try to find out which is best, safest and with the least cost to the company.

The advertisements in the magazine are helpful in keeping in mind new tools that are being manufactured for different jobs.

## Wilfred A. McCoy, Jr.

*First Year Machinist Apprentice*

The three issues I have, January, February and March, 1936, all seem to be crammed with new ideas. The idea of describing new methods and short cuts as used in other shops appeals to me for I believe that anyone who fails to watch his competitor and is unwilling to accept a good idea from him, is lost at the start. It is often remarked that it is little tricks of the trade that make a master, and watching this magazine I have found it to be full of the little tricks.

## Joseph J. Plohans

*Third Year Machinist Apprentice*

This magazine evidently was designed primarily for railway supervisors; but as it is my ambition, and no doubt every apprentice has the same ambition, to become a railway supervisor, I find that the information in your magazine, coupled with my immediate training, will provide a suitable background for a supervisory position in the railway shops.

## F. W. Macey

*Third Year Blacksmith Apprentice*

The way in which I believe I will benefit from the *Railway Mechanical Engineer* is by reading all of the articles and becoming acquainted with all parts of the locomotives and their making, thus enabling me to know better the use of the different pieces I have to make.

## EDITORIALS

### **The Influence of Diesels On Locomotive Maintenance**

A question which is frequently asked these days is "What effect will the introduction of Diesel power have on the locomotive maintenance problem, particularly with reference to the character of repair methods and repair shop equipment?" Those who ask the question are, as a rule, persons who are liable, from a railroad standpoint, to come into direct contact with the job of repairing Diesel powered equipment in the near future or those who have a business interest in the sale of equipment used in railroad shops for repair work. It is a question which seems, at the outset, to be difficult to answer yet one which, after a little thought, almost answers itself.

The Diesel locomotive or rail car is a transportation facility which, for all practical considerations, has been in railroad service less than ten years. Most of the Diesel engines now in such service have been installed during the past five years. In spite of the interest in this type of power and "ballyhoo" which has surrounded its introduction to the railroad field there are today only about 200 locomotive or car power units in service. There is no reason, in this discussion, to become involved in any consideration of the economics of Diesel power so, for the sake of argument, it can safely be assumed that the experience of the railroads to date has been of a sufficiently satisfactory character that the Diesel will continue to be installed in rail service where the nature of the operations is such that it may be operated profitably. In order, then, to arrive at some conclusion as to the probable influence on locomotive maintenance (we speak of locomotive maintenance because the repair work of the immediate future will in all probability be performed in the locomotive repair shops) it is desirable to make an intelligent guess as to how many units may be installed in the years to come. Assume, for example, that not over 100 units per year are installed during the next ten years. We will, at the end of that period have a total of 1,200 units in service on the Class I roads. It is assumed, of course, that none will be retired during that time. Conservative estimates place the replacement ratio of Diesel over steam at 1:1.5. In other words, each Diesel installed replaces one and one-half steam locomotives. So, at the end of ten years it is quite probable that there will be about 1,200 Diesel-powered units as compared with approximately 40,000 steam locomotives; in other words, 33 steam locomotives to be repaired for each Diesel that goes through the shop. Any shop superintendent or general foreman in charge of a shop today repairing 33 locomotives a month can

vouch for the statement that one Diesel a month would not set up any serious complications in his shop. Of course it might be argued that ten years ago there were 64,000 steam locomotives whereas today there are only 43,000 and that a continuation along the same path of progress might produce a situation ten years hence where there would be, say, 2,000 Diesels and only 30,000 steam locomotives. That would mean that in a shop repairing 30 locomotives a month two would be Diesels. Still, no serious complications appear from a shop standpoint.

There is something else to consider. A Diesel-electric locomotive is, after all, a machine consisting of three major parts: The mechanical equipment, such as frames, trucks, brake equipment, draft gear, etc.; the electrical equipment and, finally, the Diesel engine. When this question is all boiled down it resolves itself into the fact that two-thirds of the Diesel-electric locomotive consists of a type of equipment with which the railroad shop has been dealing for from 30 to 90 years. The remaining third, the Diesel engine, constitutes the only new problem of maintenance. So, it seems only reasonable to say that if one can predict what may be the influence of the Diesel engine on shop methods and facilities the original question is answered.

The Diesel engine, from a repair-shop standpoint, is a problem of parts replacement—parts that are either purchased from the original builder of the engine or manufactured in the railroad shop. The parts of an engine which will in all probability need replacement most frequently are cylinder liners, cylinder heads, valves, fuel nozzles, rocker arms, push rods, crank shafts, connecting rods, cam shafts, crank-shaft bearings, pistons, piston rings and wrist pins. (This list is not, in any sense, intended to indicate the order of renewal frequency.) With the exception of crank shafts, cam shafts and cylinder liners, even assuming all such parts were manufactured in the railroad shop, there is very little, if any, machine work involved that could not be handled on existing machines. It is doubtful if any railroad could justify the installation of machine-tool equipment for the manufacture of the three parts mentioned in view of the probable small volume of work involved.

In conclusion, from a casual analysis of the problem of Diesel maintenance it does not appear that, in the next ten years at least, the introduction of the Diesel will greatly add or detract from the amount of repair work, considered from the standpoint of the shop as a whole, that the railroads will be required to perform. More important is the fact that unless some unforeseen development takes place to cause the rapid obsolescence of the steam locomotive the volume of Diesel main-

tenance, by comparison with that of steam, will be so small as not to affect seriously the character of shop methods and facilities.

## **Cultivating The Public**

The railroads have learned from hard experience that they cannot in this day and generation sell transportation in the cold, matter-of-fact way in which some postal clerks sell postage stamps. In the first place, the railroads now have and for some time have had aggressive and spirited competition, and these competitors use modern, up-to-date methods and lots of courtesy in merchandising their product. Then, too, even public servants are awakening to the fact that courtesy pays—that the American public likes to be treated with consideration, and that sometimes it may be provoked to the point where it loses its indifference and insists on demonstrating that it is the real boss.

Some railroads have made excellent progress in cultivating the public and earning its good will. Others have been less active and far less successful in this respect. The forces of a railroad are so scattered and such a comparatively large proportion of the employees come in intimate contact with the public, that the entire organization must be fully sold on a policy or a program for improving public relations, if any real progress is to be made. Unfortunately, wage adjustments and working conditions on the railroads have become too largely a matter of public interference and regulation, and politics have entered into the situation to an alarming degree.

Possibly this is one reason why many of the employees are seemingly indifferent to the welfare of their railroad, or at least fail to take an interest in extending those courtesies to the public that have been used with such marked success by merchandisers in other fields. A clerk or sales representative in a store would be cleaned out in a hurry, if he or she were as mechanical, or even grouchy, in dealing with customers as are some railroad employees. This is one reason why competing forms of transportation, which pay lower wages, insist upon longer working hours and maintain relatively poor working conditions, have been so successful in taking business away from the railroads; they have at least extended courtesies and shown a regard for the welfare and comfort of their customers which has been lacking on the part of too many railroad employees.

Are not ambitious railroad labor leaders making a serious mistake in many of their attacks upon railroad managements, and particularly in regard to their aggressive political activities? It is doubtful whether the rank and file, in general, endorse the position and sentiment of some of these leaders, such, for instance, as their advocacy of government ownership of the railroads. Would these leaders not serve the membership of their organizations better by encouraging a loyalty

to their employers, which would encourage them to give better service to the public?

One of the departments of the Association of American Railroads, which promises to be a vital factor in cultivating good will on the part of both the public and the employees toward the railroads, is its public relations staff. This has recently been enlarged and has adopted an ambitious and comprehensive program which includes 25 projects and 13 services; 11 of the projects and eight of the services have already been started in operation. The project which has attracted the greatest amount of attention is the advertising in a number of the national popular magazines. To be really effective, however, such advertising must have the co-operation of every employee on the railroads.

That form of transportation is now regarded as by far the safest. This enviable position has been achieved only by enthusiastic co-operation on the part of all of the employees. The railroads in their national advertising program are emphasizing safety, and "friendliness too." That is the spirit which will win out. Some railroads have made splendid progress in this direction, but, unfortunately, too many employees have failed to be continually thoughtful of the interests of the traveling public. All of the advertising in the world cannot overcome a handicap of this sort, and yet it must be overcome if the railroads are to prosper and continue to be the dominant factor in mass transportation.

Frequently an employee will respond to suggestions made by his fellow employees more quickly than when such suggestions come from other sources. Now is the time for the thoughtful employees, who are interested in the welfare of their particular railroad, to use their influence with the other employees, if they know that the attitude or actions of such employees are irritating the public. Many of the mechanical department employees do not personally come in contact with the traveling public. Their contribution must be that of doing everything they can to make the equipment safe, comfortable and attractive; they can also, however, use their personal influence in getting employees whom they know and who do come in contact with the public, to realize the importance of extending the courtesies and consideration which are due to any purchaser of service or merchandise.

## **A Remarkable Locomotive**

The Norfolk & Western single-expansion articulated locomotive which is described in this issue is an interesting development in steam motive power in a number of particulars. One of the details of design to which attention should be called is the new method of roller-bearing application to the driving wheels by which the bearings are mounted within the wheel hubs and the pedestal-bearing construction is considerably simplified.

The most striking fact about these locomotives is

their performance in which they have demonstrated their ability to develop over 6,000 drawbar horsepower through a range of speed from 32 to 57 miles an hour. A maximum of 6,300 drawbar horsepower was developed at 45 miles an hour. This is believed to be the highest horsepower on record for a steam locomotive in America and probably in the world.

This locomotive bears an interesting relation with two other types of motive power for high-capacity freight service. About eight years ago a number of eight-coupled single-expansion articulated locomotives were built, the larger of which out-rank the N. & W. locomotive in weight, heating surface and tractive force. Notable examples of this group are the Northern Pacific and Great Northern locomotives. The former has a weight on drivers of 553,000 lb., a total engine weight of 717,000 lb., a combined heating surface of almost 10,900 sq. ft., and a rated tractive force of 140,000 lb. The latter has a weight of 544,000 lb. on drivers and 631,000 lb. total engine, with a combined heating surface of approximately 11,400 sq. ft. and 146,000 lb. tractive force.

Others of the early single-expansion eight-coupled articulated locomotives which compare closely with the N. & W. locomotive in weight cannot compare with it in capacity because of the smaller firebox and boiler proportions. The locomotive which compares most closely with the N. & W. in boiler proportions has considerably higher weights. This is the Southern Pacific oil-burning 4-8-8-2 type built in 1928 which weighs 614,600 lb., of which 475,200 lb. are on the drivers. It has a combined heating surface of 9,475 sq. ft. and a firebox with 139 sq. ft. of nominal grate area.

In two respects, other than wheel arrangement, the N. & W. locomotive differs from the earlier single-expansion locomotives. These are its larger driving-wheel diameter and higher boiler pressure. The earlier locomotives all have 63-in. or 63½-in. drivers, while those of the N. & W. locomotive are 70 in. in diameter. Its boiler pressure is 275 lb., while that on the earlier locomotives is 235 to 250 lb.

The other comparison is with the single-unit, ten- and twelve-coupled locomotives which were built at about the same period or a few years later. The Chesapeake & Ohio ten-coupled locomotive built in 1930 compares closely to the N. & W. locomotive in boiler proportions and total weight, but is considerably lighter on drivers. The driving-wheel diameter is 69 in. Including the booster with which the locomotive is equipped, however, its tractive force slightly exceeds that of the N. & W. locomotive. One of these locomotives, altered by increasing the cylinder diameter from 29 in. to 29½ in. and by increasing the boiler pressure from 260 lb. to 265 lb. so that its rated combined tractive force is 110,000 lb. (3,400 lb. more than the rating of the locomotive as originally built), developed a maximum of 5,855 indicated horsepower at 33 miles an hour in a test during which it averaged 5,400 horsepower over a considerable period. This

is an indicated horsepower for each 96.7 lb. of total engine weight.

The Union Pacific twelve-coupled locomotives have about 1,000 sq. ft. less combined heating surface than the N. & W. locomotive and are somewhat lighter both in weight on drivers and in total engine weight. The driving wheels are 67 in. in diameter and the boiler pressure 220 lb. With a tractive force of about 96,700 lb. these locomotives, in service, are reported to have developed an indicated horsepower of over 4,900—a horsepower for a fraction less than 101 lb. of total engine weight.

The indicated horsepower of these locomotives should be compared with the indicated horsepower of the N. & W. locomotive. While the figures are not yet a matter of record, they can scarcely be much below 7,000. For a freight locomotive, particularly for an articulated locomotive, the development of an indicated horsepower with less than 85 lb. of total engine weight and a drawbar horsepower with 90.5 lb. of total engine weight is a notable achievement. A limit of 100 lb. per drawbar horsepower is not exceeded within a speed range of about 30 miles an hour.

## NEW BOOKS

**ENGINEERING QUESTIONS AND ANSWERS.** *Published by Emmott & Co., Ltd., at the offices of the Mechanical World, 28 Bedford street, London, W. C. 2. 176 pages 7½ in. by 9½ in. Cardboard bound. Price, 6 shillings.*

This book is the first of a proposed series in answer to frequent request that the questions and answers section of the (British) Mechanical World and Engineering Record be published in book form. The volume starts with the beginning of the year 1934 and covers part of 1935, the projected second volume to continue from that point and carry on with the answers of 1936. The questions originated out of the difficulties and problems encountered by engineers in the course of their work.

**DIESEL LOCOMOTIVES AND RAIL CARS.** *By Brian Reed. Published by the Locomotive Publishing Company, Ltd., 3, Amen Corner, E. C. 4. 190 pages, 8½ in. by 5½ in., cloth binding. Price six shillings.*

In introducing this book, the author ventures the opinion that progress in employing rail traction units powered by heavy oil engines has not been slow and that from a technical point of view the experimental stage has been passed, except in the case of engines of 2,000 hp. and upwards. The book deals with the advantages of Diesel traction and the development of the use of Diesel power, both in this country and Europe. A chapter on railway requirements for Diesel power goes into considerable detail in outlining the requirements of the service and the type of power which has been adapted to it. Succeeding chapters in the book contain descriptions of well-known engines as well as information on engine auxiliaries and transmission systems—mechanical, hydraulic and electrical.

# THE READER'S PAGE

## Some Bird!!!

TO THE EDITOR:

Car Foreman T. J. Neubauer at Port Huron, Mich., submits the following in reply to the query on page 313 of your July issue as to "What is a Car Foreman?"

"A car foreman is a sort of bird. In fact he is several kinds of bird.

"First of all he must be able to see in the dark, so let's call him an owl. At night while other supervisors are home snoring or out making whoopee, the car foreman must keep his eagle eye on the business of the road.

"He must also be a duck and be ready to weather the storms while back shopmen and other railroad employees are able to sit comfortably by their firesides and peacefully smoke their pipes.

"He must be a species of hawk and be ready to pounce on other lines for trying to slip defects over which they should have taken care of themselves.

"Last, but by no means least, he must be a goose and take unbearable brow beatings from master car builders, A.A.R. inspectors, I.C.C. men, main office time-keepers, general superintendents and countless others, whose chief duty is to prey, like vultures, on car foremen.

"Therefore, I would say he is a bird of a very rare species. From whence he comes no one knows, but his chief duty is to help put the eagle on the American dollar for his railroad."

CHARLES CLAUDY,  
Master Car Builder.

## Another Enginehouse Foreman Philosophizes

TO THE EDITOR:

Having read the article "So You'd Rather Be a Puritan" in the *Railway Mechanical Engineer* for July, 1936, page 317, I'm moved to say hats off to the philosopher who so ably sums up the discussion which originated with the publishing of the "Roundhouse Foreman's Daily Log" in the *Railway Mechanical Engineer* for May, 1935, page 207.

Several years ago I heard an old timer remark that he thought the roundhouse foreman was the most abused person on the railroad. The statement may be a bit overdrawn, but, supposing it is true in part, I would like to ask who is at fault for things remaining as they are at the present time? Are we to assume that the foremen continue to work as they are just because they are too busy to undertake the extra effort required to bring about the conditions desired? Or possibly it is because of a lack of leadership among the supervisory forces, in that nobody wants to risk bringing down the wrath of his superior officers and thus reduce his chances of further promotion by being classed as a radical from that time on?

Perhaps it is due to indifference on the part of those foremen at smaller terminals having it a bit easier than those employed at the larger points where the work is much heavier, as is evidenced by the comment of one

foreman who stated that he was able to take part in a number of social activities, and his church work was all up in good shape and his job was all that could be desired.

At the time of my promotion it seemed that the higher salary was the means of bringing about a lot of things, such as owning a house, but as I cast about me and from what I can learn from personal contact with other foremen, it seems that in a great many cases they spend as they earn and none of them is on the road to wealth. On the other hand, the man at the bench by a little self denial is going right along and making the regular payments on his home and, since he works an eight-hour day, he has ample time to do a little landscaping or follow up anyone of a dozen hobbies. The man at the bench keeps his health and, as I see it, is really getting ahead faster than the man who is working unreasonable hours for the sake of bearing a title—and a minor one at that.

As for continued promotion the chances are becoming more remote due to the closing of the smaller enginehouses and extending the locomotive runs along with the consolidating of division points; the increase in work resulting therefrom isn't helping old Jim Evans get home any earlier each evening. Tragic, is it not, when you stop to think that we pass this way but once.

The benefits of the shorter workday are known everywhere, yet I can recall the dire predictions made by the skeptics when the 16-hour law was passed to regulate the working hours of train and enginemen. We can look back and see that the decrease in train accidents has been brought about by having men handling trains who are fully rested and alert at all times. Wouldn't it be logical to assume that a reduction in shopmen's injuries will take place when the roundhouses are run by men who are fully rested and are right out in front?

Supervisors generally know how much hard work they can stand and set the pace so as to be in the race at the finish of the day's work, and it can be readily seen that a foreman working eight hours a day will consistently turn out a better day's work than one working twelve or more hours per day, held back by that tired feeling that makes them sluggish in their actions and generally hard to get along with.

It seems to me that improved working conditions for foremen would go far toward promoting harmony in all departments and reduce the labor turnover to a minimum; it would eventually spread to the rank and file and the general rise of efficiency would more than offset any increase in payroll incurred by putting on such extra foremen as necessary to make the eight-hour day for foremen possible.

The three shifts for foremen would make it possible for the managements of the different railroads to build up a strong personnel because of having a larger number of tested men to pick from for the more important positions.

It remains to be seen who will be the first to pioneer the venture in human engineering. There is no question but that the officers of the railroads are cognizant of the benefits to be derived from the eight-hour day, but each one of them seems to be waiting for some one else to "bell the cat."

ENGINEHOUSE FOREMAN.

# Gleanings from the Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

## Challenge to Enginehouse Foremen

I wager that with the most of them (enginehouse foremen) the first investment for new equipment should be right at home with themselves—an investment in new ideas, better shop practices and better established routine methods of conditioning their power. There is altogether too much patch work; any job worth doing is worth doing well—very well, in fact.



Photograph by Edward Bolsettsian, Brooklyn, N. Y.  
Superplenachrome Film,  $\frac{1}{100}$  second, F. 22

Pulls the C. R. R. of N. J. "Blue Comet" between New York and Atlantic City

## Personal Appearance Counts

A foreman should be very careful about his personal appearance; he should never appear hurried or worried to his men, since they have much more confidence and respect for the foreman who seems to know what he is about and presents a clean-cut appearance. Foremen in the roundhouse can make a hard job out of it, or they can have a nice, snappy organization that clicks. It's up to them.

## Roundhouse Supervision

If the days to come are half of what they are supposed to be the railroads will have to offer something better if they hope to attract men capable of doing what will have to be done. As

motive power becomes more refined and complicated with the increasing application of electric and Diesel power, as it becomes less and less a matter of strong back and weak mind, better brains are going to be needed than are likely to respond to the invitation.

## "Hell-Benders" Bust

I believe that there will eventually be a reduction in the long working hours of the supervisory forces, but I do not believe that the long hours can be directly the cause of mental and physical breakdowns. The "hat-stomper", the "arm-waver" and the "hell-bender" is, in the majority of cases, the one who breaks down. The man who is self-contained, leads instead of pushes, remembers that which should be remembered and forgets that which should be forgotten, is not going to break down mentally or physically from long working hours.

## Leaders Instead of Pushers

The game of railroading is slowly turning from the side of bluff, bigotry and egotism to the side of intelligence, broad-mindedness and tolerance. This is especially true in the supervisory forces. Observe the promotions that are taking place day by day and you will note that they are men, by a high majority, who know the game; men who are intelligent; men who have gained authority not through their pull, bluff and ability to drive men, but those who through their ability and knowledge, personality and intelligence, have placed themselves out in front, so that they are leaders instead of pushers.

## The Supervisor as an Educator

A supervisor will go far if he will learn to encourage his men for good work well done, and to instruct the ones that are lagging behind. . . . I never fail to speak a word of encouragement and compliment the man who does good work; or when I have a man who is breaking in on a new job, or is servicing some bit of equipment that he is not familiar with, to take the time to explain and show him how and what to do. If he is a little slow to catch on, I get him the manufacturer's manual or pamphlet which describes the equipment and methods for adjusting it properly, or servicing it.

## Who Can Answer This One?

Here is a poser which my wheel foreman put up to me today. Who can answer it? Engine No. 2000 is being fitted with two new 60-in. steel wheels, both of which were poured from the same mixture and in the same heat. Each wheel was bored perfectly round and parallel and as smooth as possible, to a diameter of 10 in. No tool marks were visible. The axle was turned smoothly and accurately with an allowance of .0170 in. The first wheel went on at a pressure of 180 tons, which was O. K. A pressure of 210 tons was reached with the other wheel and it still had four inches to go. Thinking it might have seized, we pulled it off, but found it in good condition. We then reduced the allowance to .0120 in. and it required 195 tons to press the wheel into place. This is excessive, but it was allowed to pass. The "lubrication" used was A.R.A. standard—12 lb. of white lead to one gallon of boiled linseed oil, freshly mixed. What caused this variation? Personally, I confirmed the amount of the tolerances, using both outside and inside micrometers.

## IN THE BACK SHOP AND ENGINEHOUSE

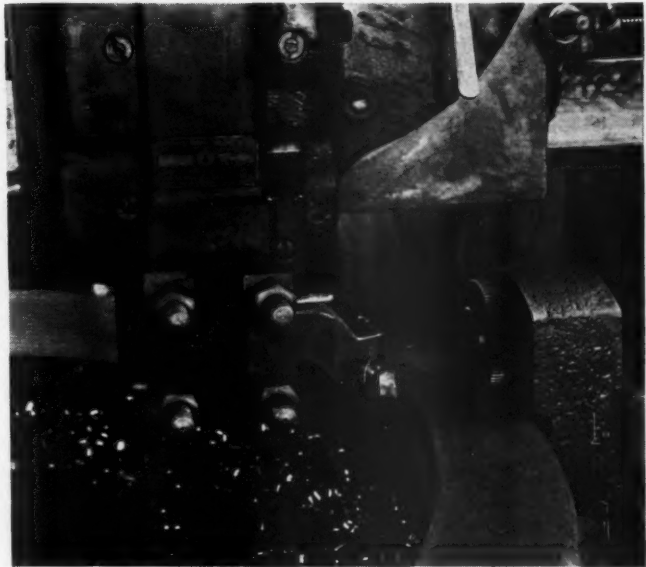
### Battle Creek Shop Kinks

Three devices, successfully used at the Battle Creek, Mich., shops of the Grand Trunk Western, are shown in the illustrations.

The first of these is a special fixture used for milling shoes and wedges or cross head slippers four at a time on a milling machine. The feature of this device is that hand-clamping is eliminated, each of the shoes, or wedges as the case may be, being supported on special jaws which slide in a T-slot and may be drawn together under heavy pressure by means of a 2-in. steel bar and yoke suitably connected to an air brake cylinder clamped to the milling machine table.

In operation the four shoes or wedges are inserted between the fixture jaws, air pressure applied, and all of the jaws and shoes drawn tight against the fixed jaw at the left end of the device. The hold-down bolt in each jaw is then tightened and the shoes and wedges are thus automatically positioned and held tight ready for the milling operation with practically no hand adjustment or tightening of clamps. It is estimated that the use of this fixture saves approximately 50 per cent in the setup time.

The second illustration shows a commonly used but extremely rugged and satisfactory hold-down device for use in clamping tires to the boring mill table when turning the inside diameter to fit the wheel center. The



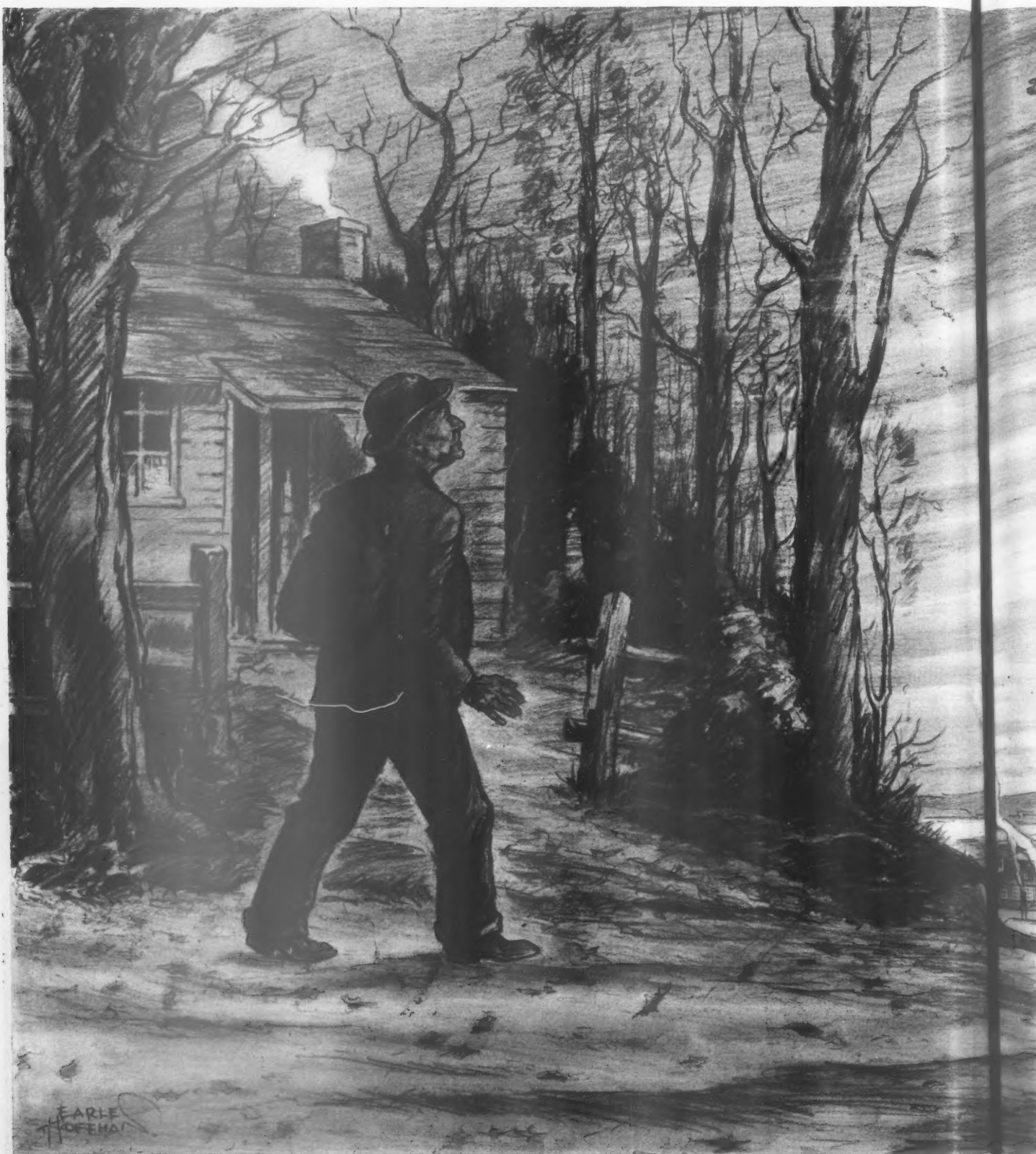
Hold-down device and cutting tool used in boring a heat-treated driving-wheel tire

hold-down device consists simply of a heavy forging hinged so that it can be swung out of the way when applying or removing the tire, and provided with a

*(Continued on page 450)*

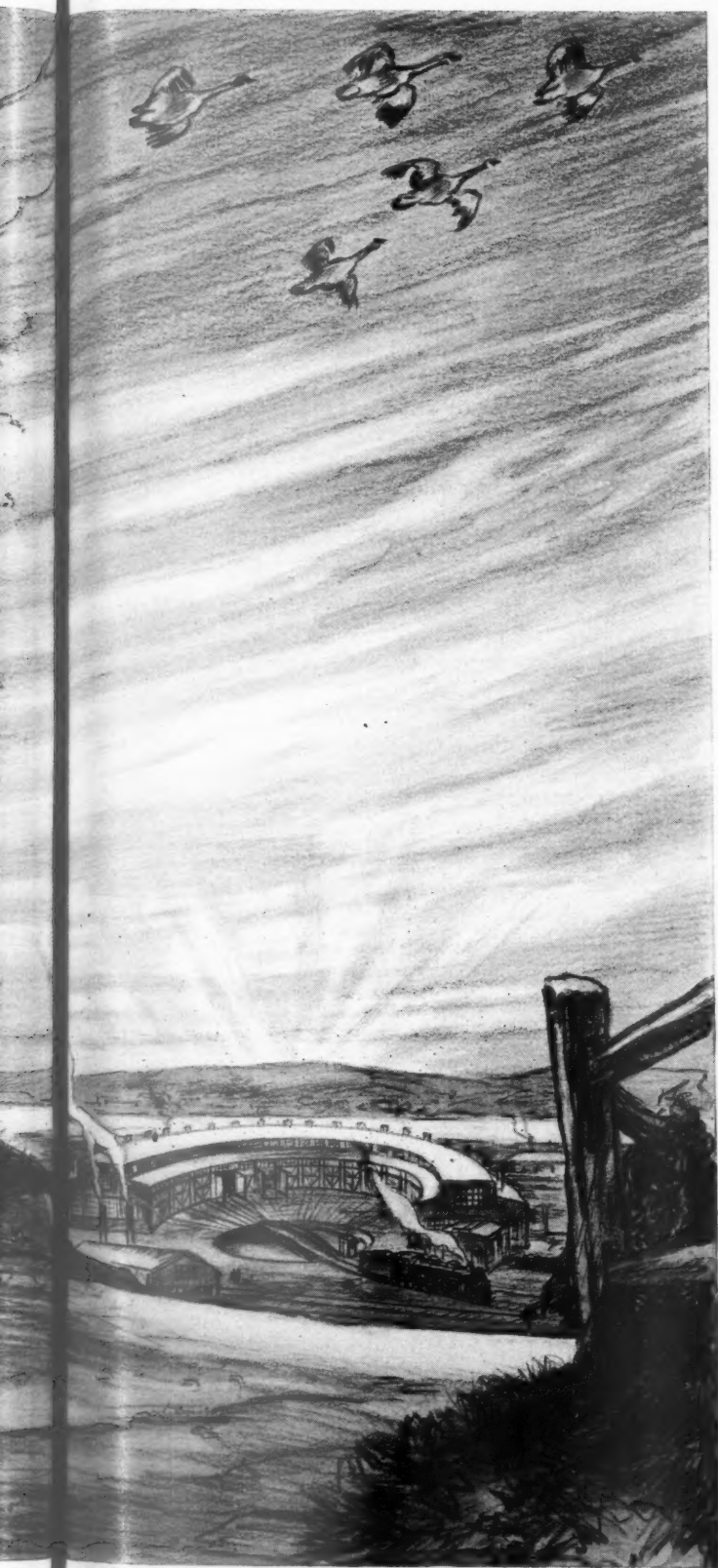
Air-operated fixture for use in milling shoes and wedges or crosshead slippers four at a time





"Guess it's about time to start getting the snow plow ready and cab curtains repaired," Evans told himself.

## ZIPPERS Would Save Time



**by**  
**Walt Wyre**

Railway Mechanical Engineer  
OCTOBER, 1936

**I**F an efficiency expert could have seen Jim Evans leaving home to go to work, he would have rated the roundhouse foreman one hundred per cent plus. Evans put on his hat, kissed his wife, opened the door, took a chew of "horseshoe," and was on his way to the roundhouse all in less time than advertised experts can roll a cigarette.

Evans shivered slightly. The crisp, cool air that met him was like opening the door of an over-cooled air-conditioned car on a hot day. Overhead a flock of honking geese were off to an early start on their way to the south for the winter. Like most tourists, when the time came to go, they were impatient to be on their way.

The foreman heard the honking and scanned the skies overhead, but only after several moments was he able to locate the flying wedge of geese in the gray light of early morning.

"Guess it's about time to start getting the snow plow ready and cab curtains repaired," Evans told himself.

Some one else must have seen a flock of migrating geese or else looked at the calendar, for there was a traingram on the foreman's desk instructing him to have the rotary snow plow made ready for service and see that cab curtains were in condition. The foreman laid the message in a basket on his desk and looked over the rest of the mail. There was a letter from the master mechanic commenting rather caustically on engine performance and another suggesting that he, the master mechanic, was getting tired of telling the foreman that overtime must be reduced.

The 7:30 whistle reminded Evans that the day force would soon be ready to go to work and it was up to him to have the work lined up for them at 8:00.

"How you coming on that patch in the fire-box of the 5064?" Evans asked a pot-bellied boilermaker by the name of Barton.

"Getting along pretty well, considering," Barton replied. "I've got a little more chipping to do then I'll be ready to start driving rivets."

"When do you think you'll get it done?"

"Oh, ought to make it before noon."

After work slips were distributed, Evans went back to the office.

"Old guess-and-growl wants to speak at you," John Harris, the clerk, told the foreman.

Evans cranked the office phone three times for the dispatcher. After the second attempt, an answering tinkle acknowledged the call.

"Hello . . . Yes, this is Evans."

"We'll want engines for two stock trains east, a booster 2800 about 11:00, and a 5000 about 3:00," the dispatcher said, "and I'd appreciate kettles that'll get out of the yard without using a pusher." The Plainville yards are down hill going east.

"You tell me when and what you're going to run and we'll furnish the power!" Evans retorted. "It'll be the 2836 on the first one and probably the 5064 on the second. Let you know definitely later."

"Say, Mr. Evans, we ain't got no air."

The foreman slapped the telephone receiver on the hook and turned around. The speaker was boilermaker helper Bill Cox that helped Barton.

"What's the matter, Bill?" Evans said. "Did the

stationary fireman forget to start the compressor again?" "No, sir," said Cox, "It's the air compressor—broke down."

EVANS snapped off a chew of "horseshoe" and headed for the stationary plant located on the other side of the roundhouse from the office. He passed through between stalls eleven and twelve where machinist Jackson was boring the cylinders on the 2870, or rather had been boring them. The boring tool was idle and so was Jackson, assisted by his helper. Evans paused. "What's the matter?" Then he remembered the boring tool operated by air and he kept on going.

"What's the matter—no air?" Evans asked the stationary fireman.

"Compressor broke down. You know it's been giving trouble a long time," the stationary fireman reminded. "It might have been a good one when George Westinghouse was making his first experiments, but it's as out of date as flour sack underwear for girls now."

"I'll get a couple of machinists on it." Evans headed back so fast that he almost spit in his own face.

Five minutes later the foreman returned with two nut splitters, followed by two helpers, each carrying an armful of tools. The machinists tore into the air compressor like a Scotchman looking for a favorite dime.

"Well, it looks like the air compressor will be out of commission a couple of days," Evans remarked. "Guess we'd better set up a locomotive compressor. Fix it up like you did last time and get it done soon as you can," he told the machinists.

Evans went back to the roundhouse to see how things were stacking up there. He met the clerk at the board.

"Dispatcher wants to know what engine for the second stock train," Harris told him.

"I'll let him know in a few minutes."

Evans went down to the 5064 to see how Barton was getting along. Barton was doing his best using a hand chisel and hammer, but his best was like "the cat ate the grindstone"—a little slow.

"How you coming?" Evans stuck his head in the fire door and yelled.

"Not too good," Barton replied. "Soon as I get this chipped out I'll be ready to weld the patch, then drive the rivets."

Evans reflectively rolled his chew of "horseshoe" over with his tongue. "Better work noon hour if you have to get it done."

"We'll have to have a pair of trailer wheels for the 5081." Evans, climbing down from the cab of the 5064, looked over his left shoulder to see machinist Barnes leaning against a column waiting for the foreman. "The journal is cut," Barnes said, "pretty bad."

"Well, go ahead and put in a pair," the foreman said a little testily.

"There ain't any 5000 trailer wheels."

"Sure?"

"Yep; I looked all over and then asked the storekeeper—asked him twice. He's said 'haven't got it' so much it's a habit and I asked the second time to be certain he knew what he was talking about."

"All right"—Evans took a fresh chew—"get a pair off the 5072. She's tied up waiting for a set of tires. I'll go see the storekeeper."

"How about trailer wheels for 5000's?" the foreman asked the storekeeper. "Got any ordered?"

"Yeah; ought to be in next week. We got four pairs for 2500's," the storekeeper added.

"I'm not interested in 2500's," Evans said sharply. "They've all been sent away except one and it's leaving this week, soon as the 2842 gets back from the shop."

"Jumping Caesar!" the storekeeper ejaculated, "and we've got a bunch of supplies for 2500's coming in the next car."

"What is it?—bananas?" Evans chuckled. "That's the only thing I can imagine the store department getting in bunches."

"If the mechanical department would let us know what kind of material was going to be needed, and when, we might be able to keep supplies," the storekeeper retorted. "Look at that stuff for 2500's! Two handlings on all of it and none used."

"Rush them on them trailer wheels," Evans replied as he started back to the roundhouse. He knew that the storekeeper was partly right in what he said. No small part of the material shortage could be laid at the door of the mechanical department for not letting their material requirements be known in advance.

"The dispatcher is having conniptions," the clerk said when he had found the foreman. "He's called three times wanting to know about the stock train engine."

"Tell him the 5064." Evans drowned a bug with a sluice of tobacco juice. "What time does he want it?"

"Three-fifteen," the clerk replied.

"I hope he gets it," the foreman said in the same tone a theater patron uses when expressing a desire to win the money on Bank Night. "Tell him we'll do the best we can. The air compressor broke down and delayed things."

Evans stopped at the drop-pit to see how the dead work gang was getting along with the 5097. He had told the master mechanic that the engine would be ready to go in a couple of days. The foreman brightened up when he saw how work was progressing on the classified repairs. The engine was wheeled and machinists were ready to start putting up the rods. With any luck at all, she'd be ready for a fire by noon next day. Then wouldn't the master mechanic be surprised!

EVANS went the the office in right good humor. He looked at his watch—11:10. A muffled rat-tat-tat told that the emergency air compressor was working and so were the boilermakers. Perhaps there wouldn't be any delay on the stock train after all.

The foreman leaned back in his chair and propped his feet on an open drawer of the desk. He was resting easy figuring what bait to use that might land the big trout that got away two weeks before. The next Sunday was his day off and he was going to have one last try for the speckled beauty before the season closed. He had just about decided on using a gray hackle with a yellow body on a number six hook when the engine inspector came in.

"Right crosshead broken on the 5085," the inspector announced.

The trout got away again, mentally, at least. "Tell the hostler to get the engine in the house soon as possible so we can get to work on her. We've got to use her tonight on No. 10." Evans followed the inspector out to the inspection pit.

The crosshead was broken and would have to be replaced. No doubt about that. The foreman headed for the roundhouse like he was going to a fire. He found machinist Jenkins and told him to caliper the guides on the right side of the 5085 so that the machine man could start planing a crosshead without delay.

When Evans returned from lunch, he went to the roundhouse first thing to see how the 5064 was getting along. It wasn't so bad. Barton had finished the patch and the boiler was being filled. The fire-builder was waiting to start a fire in her the moment water showed in the gage glass. "Give her all she'll stand," Evans

told the fire-builder and went down to the 5085 just as the 1:00 whistle blew.

"Did you get Harrison lined up to start right in on the crosshead?" Evans asked Jenkins.

"There wasn't any crosshead in the storeroom," the machinist said. "That is, there wasn't one that'll fit a 5000."

The foreman spat out his chew of "horseshoe" as though it had sand in it. He walked away four or five steps and turned and came back. He stood for a moment, brows puckered, eyes half closed, and absent-mindedly felt for his plug of horseshoe.

Still thinking of the crosshead, Evans bit down on what he thought was chewing tobacco. The tobacco seemed tough. He bit harder. Then he discovered that he was trying to bite a corner off a hunk of asbestos packing, a sample handed him by a supply salesman the day before. He swore and threw the sample of packing away.

"Dammit—guess we'll have to rob one off the 5097." Evans found his plug of "horseshoe" and examined it carefully before biting off a hunk about the size of an old style three-quarter nut.

Gone were the chances of getting the 5085 out the next day. The best that could be done would be three or four days getting a crosshead, then the storekeeper would have to wire for it and have it shipped passenger. The management didn't approve of shipping heavy parts by passenger, either.

The second stock train got out almost on time. It was called for 3:20 and got out at 3:30. The ten minutes were lost making up the train. No use telling that the engine wasn't ready either.

Engineman Foster came in on the stock train. Evans was in the office when the engineer came in to make out his report.

"Say, that reverse gear on the 5066 that I came in on. It's in bad shape," the hoghead said.

"What seems to be ailing it?" the foreman inquired.

"Creeping; it won't hold anywhere. I reported it last trip and it's worse now. It came pretty near working in reverse just this side of Middleton. Mighta tore something up if it had. Better fix it," Foster advised.

"O.K., we'll get it," Evans replied looking out the window to see if the 5064 was about ready to get away. He couldn't tell by looking and went out to see. Just as he left the office the engine pulled out.

The foreman went on to the roundhouse. "How you coming on that crosshead? Got it off yet?" he asked machinist Jenkins.

"Oh, yeah. It's in the babbitt shop. The copper-smiths are getting ready to pour it now, I think."

"Getting ready to pour it?"

"The guides on the 5085, they're a little narrower than the ones on the 5097. The crosshead will have to be babbitted and planed to fit."

"Now ain't that nice!" Evans said in a tone that meant it wasn't nice at all.

**TRYING** to explain overtime with prospects of more overtime piling up to be explained is never very nice, particularly with a master mechanic like H. H. Carter that doesn't care much for explanations unless preceded by the desired results.

Evans figured mentally a moment, then walked away. There was nothing to be done about it. The Limited had to run. It couldn't run without a locomotive. The only locomotive available was the 5085. The locomotive couldn't run without a crosshead. The only crosshead available wouldn't fit without babbitting and planing. Then it had to be put on. Just like a geometry problem

solved by axioms, and it had two answers. One was overtime. The other—the 5097 wouldn't get out the next day as expected and it would be up to Evans to explain both.

"Well, tell them to rush work on the crosshead much as possible and you and your helper work overtime to put it up, and while you are waiting, take a look at the reverse gear on the 5066. The engineman that came in on it reported it leaking bad."

The machinist gathered up some tools and started down to the 5066. The engine had been put in the house in stall twelve. Evans took a turn through the roundhouse to see how things were getting along and went back to the office hoping to get a few moments rest before five o'clock came.

A second time for the day he got comfortably seated in his favorite position. Things weren't going any too good, but worrying wouldn't help. Again he thought of the big rainbow trout that two weeks before had struck short and turned up his nose at every tempting bit of fluff, feather, hair, or tin that had been offered in various combinations.

"Perhaps a plain coachman fly with a spinner ahead of it would do the trick, or maybe a shimmy wiggler," Evans was debating lazily in his mind.

"Leather's worn out in the reverse gear of the 5066." It was machinist Jenkins.

"Tell Martin and his helper to put in a new one. You better get back to that crosshead. I want to get it soon as possible." Evans again relaxed to his mental battle with the wiley trout. He was just about to land the poor fish on a medium sized spoon when Machinist Martin came in.

"They haven't got any leathers for the reverse gear in the storeroom," the nut splitter informed the foreman. "What'll I do about it?"

"Rob one off the 5097," Evans said wearily. "It's getting to the point that an engine on the drop-pit is not there to be repaired; it's there to be robbed."

"Want me to finish it?" Martin asked.

"No-o—let the night men get it if they have to run the engine tonight."

"O.K." The machinist turned and started back to the roundhouse.

The phone rattled sharply. John Harris lifted the receiver. "Yes, clerk talking . . . Don't know. I'll ask him." Harris turned to the foreman. "The dispatcher says there'll be two sections of the Limited tonight and wants to know what engines you're going to give him. What'll I tell him for the second one?"

"Tell him the 5066," the foreman answered as he went out the door to catch Machinist Martin and tell him to work overtime on the engine.

Time passed on, ten days of it. Evans didn't catch the big trout, but, by golly! he'd get him the first Sunday he had off when the season opened next Spring, even if he had to use worms or grasshoppers.

One morning Evans went through his usual ritual of putting on his hat, kissing his wife, opening the door, and taking a chew of "horseshoe." When he opened the door a gust of cold air slapped him in the face and settled a whirling snow flake on his nose. "Where's my sweater?" he asked his wife.

"Right here on a chair. Thought you might need it today and got it out last night," his wife replied.

When Evans reached the office he found the message he was expecting, wanting to know if the snow plow was in shape for service and cab curtains in good condition.

"Get the snow plow in the house first thing," the foreman told the hostler.

Soon as the eight o'clock whistle blew, Evans told the

cab carpenter to get busy putting on cab curtains and cooping cabs. He told the machinist assigned to the rotary snow plow to look it over and test it out.

While Evans was talking to the machinist, the cab carpenter returned from the storeroom. "There's not any cab curtains in the storeroom," the carpenter said.

"Well, tell the storekeeper to wire for them and get them soon as possible."

About three o'clock in the afternoon the machinist that was looking over the snow plow came to the office. "There's not any dynamo on the snow plow and several valves are missing—been robbed," the machinist said.

"Now what the hell! Where's the dynamo?" Then Evans remembered. It had been taken off to put on a pile driver early in the summer. No chance of one in the storeroom. "Tell the electrician to get one off the 5092. She'll be tied up on the drop-pit several days, and tell the coppersmith to get the valves replaced."

"What do you mean most of our overtime is because of lack of material, then say it's partly our fault?" the master mechanic asked Evans a few days later.

Evans shifted his chew of "horseshoe." "Well, robbing dead engines of parts necessary to keep live engines going accounts for a lot of wasted time and—"

"Wouldn't have to do it if the storeroom had the parts," the master mechanic interrupted.

"That's true," Evans replied, "but maybe if we'd be a little more careful about ordering stuff we don't use and work with the store department a little better they'd keep stuff we do need."

"Perhaps. But anyway, overtime must be cut out."

Carter left with the ultimatum.

## Battle Creek Shop Kinks

*(Continued from page 445)*

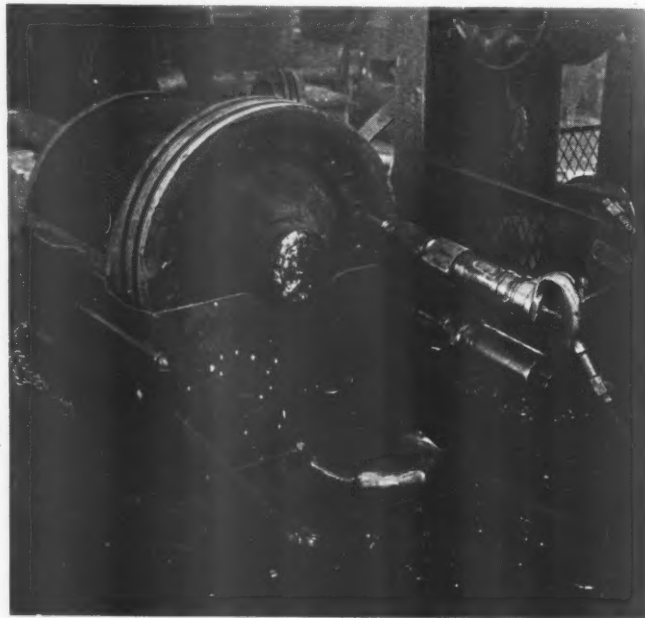
knurled and hardened eccentric wheel which contacts the upper surface of the tire and tightens under the pulling action of the cut. The tire illustrated is a 73-in. heat-treated tire which presents some difficulties in machining unless a powerful and accurate boring mill is used and a cutting tool which will stand up to this heavy duty. Roughing cuts are taken with a special form of cutting tool, made of Rex AA steel, the cutting speed being 20 ft. per minute and the feed  $\frac{7}{32}$ -in.

Some difficulty is experienced in taking the light finishing cuts on these heat-treated tires and this problem has been solved at the Battle Creek shops by the unusual expedient of speeding up the work to about 200 ft. per minute and using a  $\frac{1}{64}$ -in. feed. This gives a finish which looks almost as smooth and accurate as grinding. The first part of the cut, shown in the illustration, is being made at this high rate of speed and low feed, with a sharp-pointed carbide alloy cutting tool.

The third illustration shows an unusually convenient and effective device for removing the rivets from composite pistons built up of cast-steel centers and separate bull rings. The device consists simply of a sheet-metal housing around a double pair of rolls (old headlight generator ball bearings) arranged to support the piston rod and piston in such a way that they can be conveniently revolved. The end plate of the housing carries a small air cylinder and a lever arm device for supporting the pneumatic hammer used in backing out the rivets.

In using this device, the rivet heads are first burned off with an acetylene cutting torch; the air hammer is centered against one of the rivets; air pressure is applied

to the small intermediate cylinder, bringing the punch tightly against the rivet; the pneumatic hammer is operated and the small cylinder moves the hammer forward, as rapid repetitive blows from the punch force the rivet back out of the hole. The machine is operated by one



Convenient and safe air-operated device for backing out piston bullring rivets

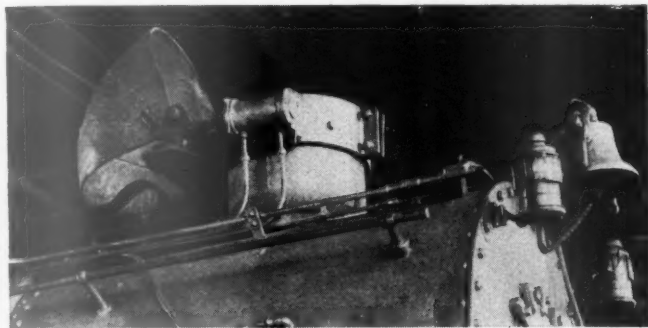
man and it will be noted that a small but convenient seat is provided, as the operator would otherwise have to bend over low or kneel on the floor.

After removing one rivet, all that the operator has to do is to release the air in the small cylinder, pull back the pneumatic hammer, turn the piston to the proper position and he is ready for the next one. As a safety measure, a substantial wire mesh screen is provided over the back of the device to catch all rivets and prevent any possibility of their flying out and causing personal injuries.

**ACCURATE MEASURING**—The following is vouched for by a division superintendent of the Atchison, Topeka & Santa Fe: The division on which he was at the time this happened was handling a heavy traffic, and in response to a call for additional power a number of Santa Fe type locomotives were transferred from another division. These locomotives, having small diameter drive wheels, were bulletined to travel at a rather limited speed. Shortly after these locomotives were put on the division, the roadmaster reported a bunch of badly kinked rails in a sag where it was found that one of these locomotives had been operated considerably in excess of the speed limit. The superintendent questioned the engine crews that had been on all of these locomotives and all of them denied having exceeded the speed limit. What to do? He thought it over a couple of days and finally had a happy thought. He asked the division engineer to send a couple of men out to measure the circumference of the main drivers on each of these locomotives as accurately as it was possible to do so, and as luck would have it, he found that there was an appreciable difference—in fact, as much as seven inches in the circumference of these drivers due to the difference in tire wear. He then sent these engineers out on the field to measure the distance between the kinks in the track, measuring the distance over a considerable distance so as to strike an average, and found that these kinks fitted the circumference of only one of the locomotives. Upon being questioned, the engine crew of that locomotive admitted that they had been running pretty fast at the point in question.

## Locomotive Devices Used In Mountainous Country

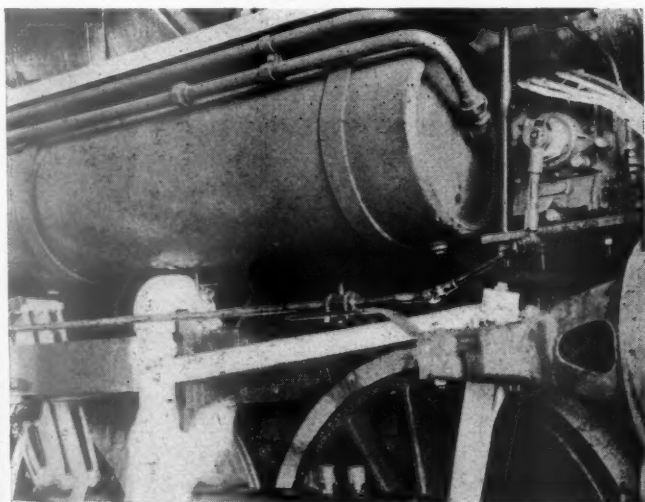
The two illustrations accompanying this article were taken at the Denver, Colo., enginehouse of the Denver & Rio Grande Western and show two devices, the value of which has been demonstrated by experience on a railroad which passes through more or less mountainous



Type of smoke deflector used on D. & R. G. W. locomotives which operate through tunnels

country and encounters some heavy grades and occasional tunnels.

In the first illustration, the smokestack is shown equipped with a heavy steel band clamped on the top and arranged to support a 90-deg. section of sheet metal elbow or hood which may be rotated so as to cover the stack opening when passing through a tunnel and deflect the smoke backwards over the locomotive and cab, thus making it possible to maintain more satisfactory atmospheric conditions within the cab itself. The hood, pivoted on a 1-in. bearing shaft back of the stack, is operated by means of a small air cylinder with rack and pinion connection to the hood and operated by an air



Detroit lubricator with driving arm which is automatically lengthened so as to deliver less oil when drifting

control valve in the cab. A substantial flat spring, shown in the illustration, serves to cushion the fall of the hood when it drops into the unused position and also provides a stop against which the hood rests when not in use.

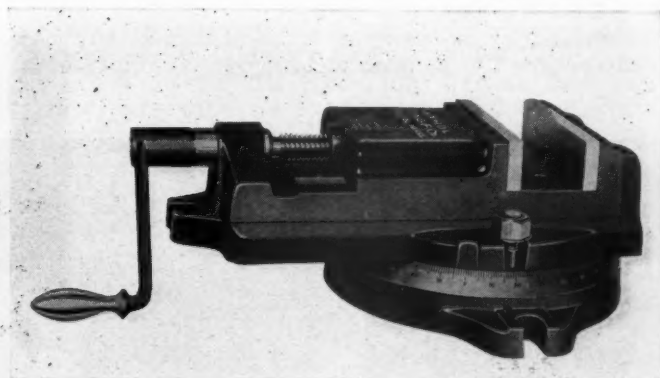
Another interesting feature of this locomotive, noticeable from the illustration, is the fact that the front cylinder and valve chamber head covers, instead of being made of pressed steel with rounded corners, are evi-

dently fabricated from flat circular steel plates to which steel bands of the proper width are welded to form the covers. The second illustration shows a D. & R. G. W. locomotive equipped with a new Detroit mechanical lubricator driven through a suitable mechanical connection to the valve gear link. It will be noted that the horizontal driving bar or rod is well supported and guided. The swinging drive rod on the lubricator itself is designed with a spring-controlled extension which permits lengthening the rod approximately 4 in. and decreasing the amount of oil delivered to the valve chambers and cylinders when the locomotive is drifting. Just as soon as it is necessary for the locomotive to work steam, this drive rod is shortened again, the length of the stroke increased, and more oil delivered to provide adequate lubrication. On certain classes of D. & R. G. W. locomotives, lengthening and shortening of the lubricator arm is done automatically when the throttle is closed or opened, and in other cases the control is entirely mechanical by lever connection to a handle within easy reach of the engineman's position in the cab.

## Milling Machine and Drill Press Vise

A milling machine vise with an easily removable swivel-indexing base, announced by Athol Machine & Foundry Company, Athol, Mass., provides for an unusually wide range of general machine shop uses. Used with the indexing base, milling machine and other operations requiring accurate angle settings are easily and conveniently handled. Removed from the swivel base, the vise is ideally adapted to drill-press and many other types of use.

The indexing base is graduated over 180 deg., extending 90 deg. each way from zero. Two clamp bolts hold



Athol milling machine vise with easily removable swivel-indexing base

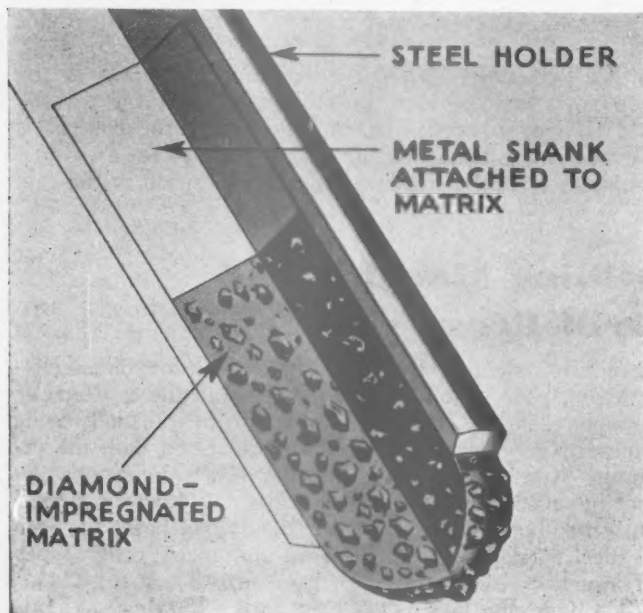
the vise bed in position on the swivel base. The vise base, bed and jaws are semi-steel castings of generous proportions. Jaw facings, of hardened tool steel, are removable. Inexpensive false jaws may be provided, shaped to hold any shaped piece. The vise screw has the Athol buttress thread, 50 per cent heavier at the root than a square thread of the same pitch. The extra metal and extra strength come just where the strain is greatest. An extra heavy shoulder is an integral part of the vise screw. The crank handle is long enough for ample leverage, and is removable.

The swivel-base milling machine vise is available in two sizes, with 4-in. jaws and with 6-in. jaws. No. 1024, with 4-in. jaws, has a depth of jaw of 1 3/8 in., opens 3 1/8 in. and weighs 45 lb. No. 1026, with 6-in.

jaws, has a depth of jaw of  $1\frac{5}{8}$  in., opens 4 in. and weighs 70 lb. Either model is available without the swivel base for use exclusively as a drill press vise, if preferred.

## Diamond-Impregnated Wheel Dresser

The Carboloy Company, Inc., Detroit, Mich., has added to its line of Carboloy cemented-carbide products a diamond-impregnated wheel dresser. The new grade



Carboloy diamond impregnated wheel dresser

contains an extra coarse mesh of diamonds and has been developed to increase the order of performance on

\* \* \* \* \*

the larger and harder grades of grinding wheels used on surface, cylindrical and centerless grinders. This extra coarse grade supplements the existing grades of Carboloy dressers containing fine, medium and coarse mesh size diamonds. With this development, the Carboloy dresser is available for all hardnesses and sizes of grinding wheels.

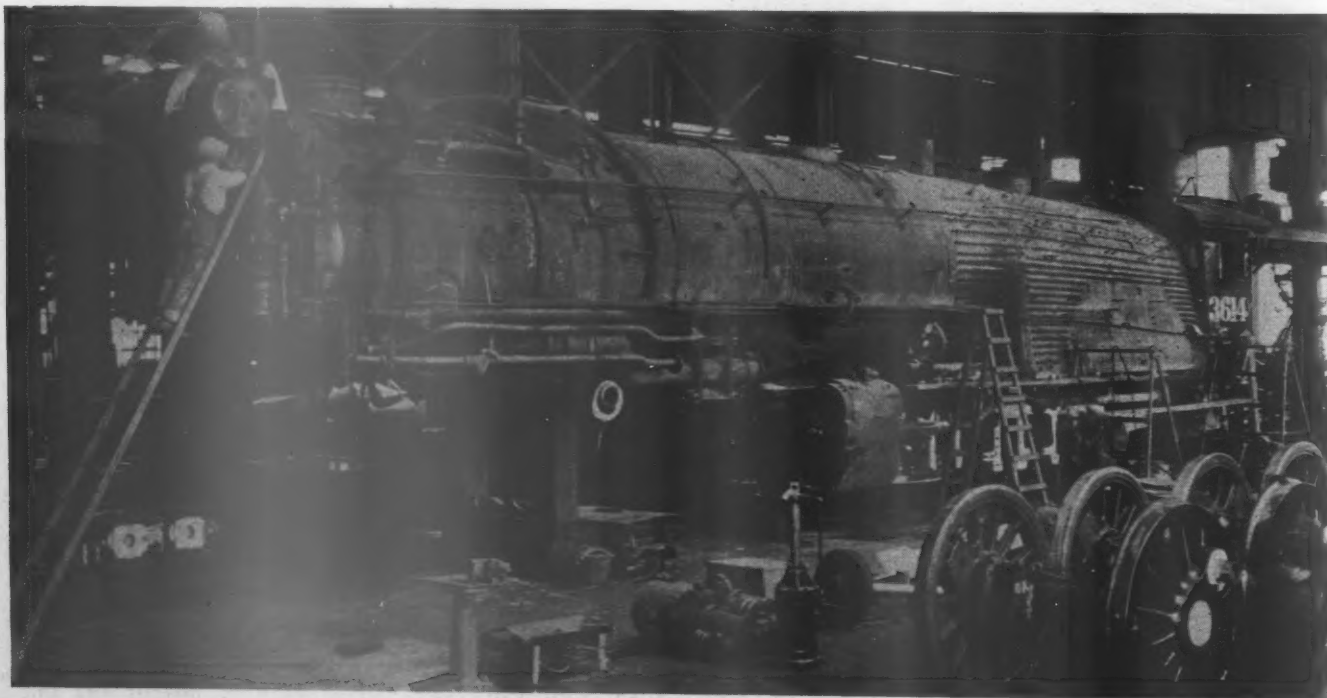
Advantages of the Carboloy diamond-impregnated wheel dresser, as claimed by the manufacturer, are that no remountings are required, they stand unusual abuse, and each dresser may be used throughout its entire life on the same size wheel.

## Ideal Electric Marker

The Ideal electric marker, a small portable tool for marking on practically any material, whether metal, or non-conductor, is announced by the Ideal Commutator Dresser Company, 1561 Park avenue, Sycamore, Ill. Legible and permanent records can be made on all metals and their alloys; on dies, tools, plates, sheets, shapes, rods, forgings, castings, pipes, equipment; and also on glass, pottery, ceramics, hard rubber, bakelite, plastics, fibre and similar materials.

The instrument is  $6\frac{3}{4}$ -in. long, weighs 2 lb., and is handled similarly to a pencil or crayon. It operates on the principle of a miniature hammer at the rate of 3,600 strokes per minute. It requires no cabinet, auxiliary controls, rheostats or transformer for operation. The point does not stick into the marking surface. It makes permanent lines, cut into the surface, that cannot be removed by ordinary wear and tear of handling.

The marker operates on 110 volt 60 cycle alternating current, and consumes approximately 75 watts. It can, also, be furnished for other standard voltages and frequencies. The unit has a 6-ft. cord with plug and on-off switch. Each marker is regularly supplied with a hardened point for working on all materials including hard steel or similar products.



One of the big 2-8-8-2 type locomotives of the D. & R. G. W. undergoing heavy repairs at Denver shops

# With the Car Foremen and Inspectors



Interior of the Havelock erecting shop as equipped for heavy car building operations

## Car Work at Havelock Shops

Since the concentration of all heavy locomotive repair operations on the Chicago, Burlington & Quincy at two main shop points, namely, West Burlington, Iowa, and Denver, Colo., the large shops at Havelock, Nebr., formerly devoted exclusively to locomotive work, have been re-equipped and organized to handle program car repairs and, in fact, the construction of complete new cars on a modern production basis. Machine tools, located in the machine shop and not needed for car repair work, have been, for the most part, removed and shipped to other shop points on the Burlington lines, the heavy machinery bay then being used for the storage of car materials, the fabrication of certain car parts, boring and turning car wheels, machining various castings, etc. One track, extending into the shop and through the center of the heavy machinery bay, provides a convenient means of getting car materials into the shop and the overhead crane assists greatly in unloading them.

In the erecting shop, as shown in one of the illustrations, three tracks extend into and through the shop building, the two outer tracks being normally used for the straight line car rebuilding operations, and the center track for material delivery and storage. The cranes are here used to great advantage for transferring material and also car underframes, bodies, etc., when necessary. Convenient scaffolds for both side sheathing and roof work are installed where needed, and, in general, these scaffolds are designed so as to occupy a minimum floor space, being supported on short sections of steel rail set

in a concrete base in the shop floor. Another illustration gives a close-up view of one of the three oxy-acetylene stations used to distribute oxygen and acetylene gas required in the welding operations. Two of these three stations are equipped to distribute high-cycle electric power at 220 volts and 180 cycles for electrically operated floor sanders, portable handsaws, drills, etc. Both the oxygen and acetylene connections, as well as those for the high-cycle electric current, are conveniently ar-



Special two-wheel truck used in applying air brake cylinders and reservoirs



The mono-rail hoist and special equipment at the truck assembly job

ranged on a short section of superheater flue set two feet in the shop floor.

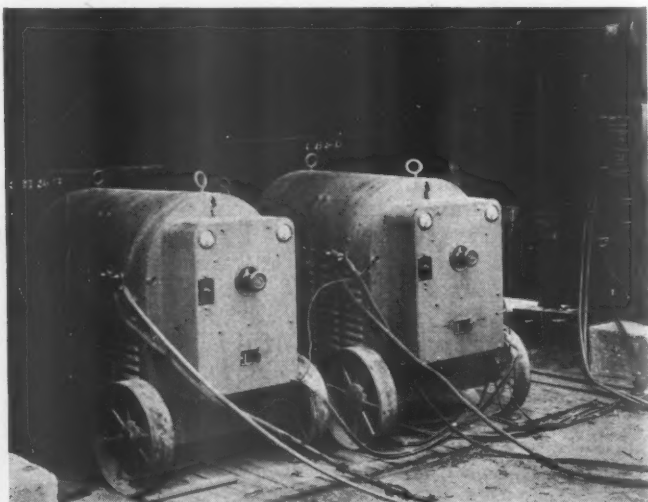
One of the illustrations shows a two-wheel cart used in applying brake cylinders and air reservoirs underneath the cars. As shown, this cart consists of a welded steel framework mounted on two 20-in. wheels and provided with two semicircular arms on one end to support the air reservoir and a long 8-ft. handle on the other to give adequate leverage for lifting the reservoir up against the car underframe and hold it securely while being clamped

and bolted in place. Incidentally, the flat section of this cart immediately above the wheels is designed to hold the triple valve while it is being moved under the car and bolted to the reservoir.

Tubular steel trestles are used for supporting car bodies with the trucks removed and also for the convenience of car men while applying and bolting siding in place. These two types of trestles are clearly shown in

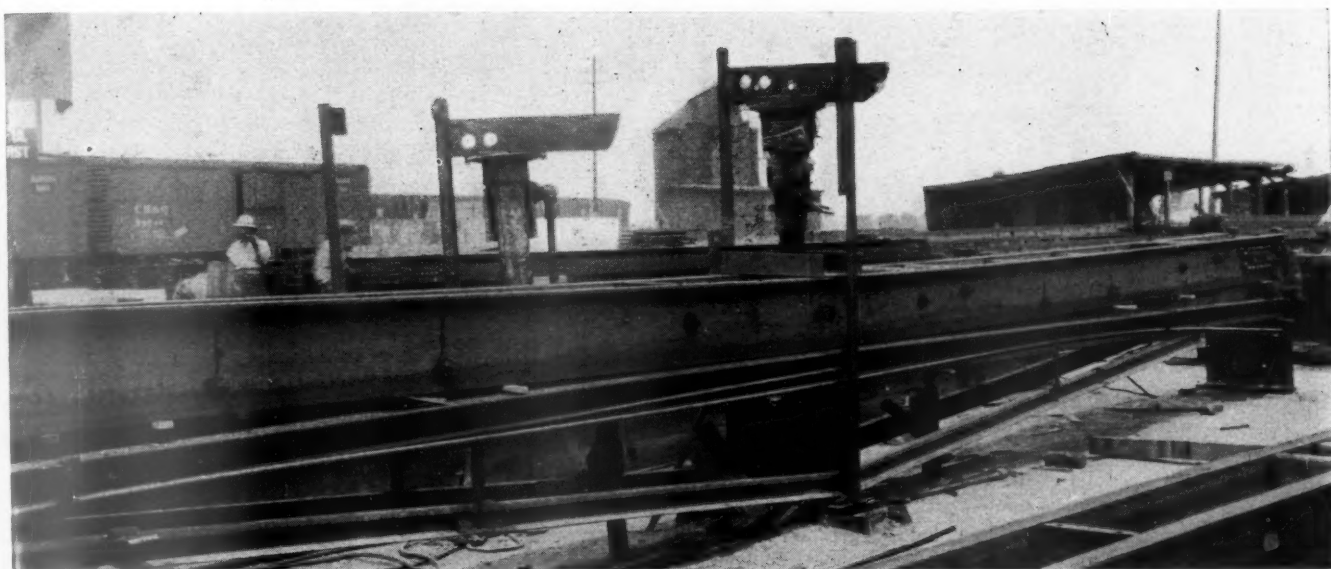


Light but strong welded tubular-steel trestles used as car supports and for workmen to stand on while bolting car siding



Two Westinghouse 600-amp. welding machines used in furnishing current for the multitudinous welding operations at Havelock shops

one of the illustrations, the first consisting of a light but strong welded tubular-steel framework 42 in. high, made of 1½-in. double-strength pipe corner posts, held together by horizontal side braces, made of ¾-in. pipe electric-welded at the corners. The top of the trestle consists of a 5-in. I-beam rigidly held in place by electric welding. Short metal retaining straps, welded to the ends of the channel, serve to help position the thin hardwood block which is placed on top of the channel and supports the car weight. This type of car-supporting trestle combines great strength with light-weight and ease of handling. As an unusually severe test, and to make sure that this trestle could be used safely, it was applied under a car body loaded with 40 to 50 tons of scrap car wheels



Jig used for giving the proper camber to center sills before they are welded

and withstood this load safely with no evidence of bending of the trestle tubes or rupture of the welds.

The siding trestle is 8 ft. high and 6 ft. long, the main A-frame members being made of  $\frac{3}{4}$ -in. pipe braced with  $\frac{1}{2}$ -in. pipe and having ladder steps made of  $\frac{3}{8}$ -in. pipe, this structure being completely fabricated by electric welding. The trestle is stiffened by  $\frac{1}{2}$ -in. cross brace pipes securely welded in place, as illustrated. The horizontal pipe sections are extended slightly beyond the A-frame toward the car to provide support for narrow

irons and trainline pipe, welded together and having the legs of the proper length so that the jig will be at the elevation needed for easy working. Twenty-six rivets, spaced on the same centers as the carlines, are welded to the upper side of the angle irons and serve to position the carlines and purlines while they are being assembled to form the frame of the car roof. The bolting and welding operations are then completed and the entire roof is applied to the car as a unit.

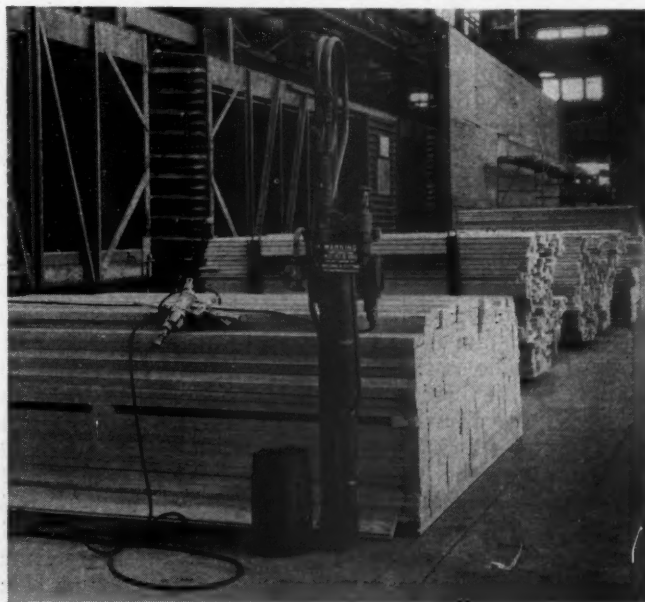
An unusually interesting method of providing the proper camber in center sills used in these cars is shown in one of the illustrations. The new A.A.R. type of center sill is used, consisting of two Z-sections which are welded together along the top center lines while still in the camber jig. This jig is made of two 90 lb. rails supported at the ends on short sections of heavy I-beam bolted to a concrete foundation, these rails being bowed at the center  $2\frac{1}{2}$ -in. by means of 90 lb. steel rail truss rods, as shown in the illustration. The purpose of this construction is simply to provide a long, stiff and rigid foundation on which the center sill sections may be



Jig for assembling roof carlines and purlines prior to bolting and application as a single unit to the car frame

wood footrests. The top step is a  $1\frac{1}{4}$ -in. plank, 10 in. wide by 6 ft. long. This trestle is amply strong and rigid to provide a firm support and footing for car men while working on the side of the car. Referring to the illustration, it will be noted that short pieces of 1 in. by  $\frac{1}{8}$  in. steel, bent in the form of an arc, are welded to the bottoms of the trestle legs. These are applied so that one man can lift one side of the trestle and readily pull it along the shop floor to whatever position may be desired for the most convenient handling of his work.

Another illustration shows a special jig for assembling carlines, purlines and the ridge pole of the car roof which is applied as a unit to the car, using either the shop crane, or a locomotive crane if the work is being done outside the shop building. This jig is made of scrap angle



One of the oxy-acetylene and high-frequency electric power stations in the erecting shop



Partial view of two strings of 50-ton single-sheathed box cars recently built at the Havelock shops of the C. B. & Q.

placed in an inverted position, blocked up at the ends and jacked down at the middle to give the desired camber. The 75-ton jack is supported in an inverted position by having its base welded to a 22-in. by 10-in. by  $\frac{3}{4}$ -in. steel plate arranged to swivel on a 1  $\frac{1}{4}$ -in. vertical pipe section on one side of the jig and be locked under a suitable lug on the other vertical pipe. This permits swinging the jack out-of-the way when inserting or removing the center sill sections. While two jacks are shown in the illustration, only one per jig is used, the jack at the left being installed on a second cambering machine.

#### Welding the Center Sills

In operation, the center sill Z-sections are bolted together and fitted up as much as practicable before the welding operation and applied in the device. The ends are blocked up, the jack swung into place and the ram brought to bear against a short channel section which rests on the two center sill sections. The jack is then operated to deflect the center sills 2  $\frac{1}{4}$  in. which has been found by experience to be enough to give about  $\frac{3}{8}$  in. permanent camber after the welding operation. In welding, the joint between the two sill sections is backed up by a copper strip underneath which gives a smooth finish to the under side of the sill weld. The weld is made by two operators using the skip method, with 6-in. welded sections separated by 4-in. spaces. From the bolster to the ends, the sill sections are welded together complete, so that approximately 75 per cent of the entire length of the sill is welded. Coated welding rod  $\frac{3}{8}$  in. in size is used for the most part for this welding operation. The two 600-amp. welding machines which furnish current for the extensive welding operations at Havelock shops are of Westinghouse design and were secured from the Denver shops.

There is nothing particularly novel about the truck-building operations at Havelock, but this work is efficiently organized and carefully done in accordance with the best recommended practice. The truck work is performed outside of the shop underneath a fixed mono-rail equipped with three movable 5-ton chain falls, as shown in one of the illustrations. This mono-rail is made of a scrap center sill channel supported about 24 ft. high and transverse of the track by means of well-braced and strong wooden side frames. The ends of the mono-rail extend about 10 ft. beyond the supporting uprights and are provided with stops in the interests of safety. The outside chain falls may therefore be used for lifting side frames at either side of the station and bring them into the truck position while the center chain falls are used to lift the bolster. With this device, truck side frames,

bolster wheels and all other parts may be assembled with minimum hand labor and lifting; and, moreover, with reasonable care, there is little danger of damaged journals or personal injuries.

#### Electric Welding at the Beech Grove Coach Shop

As in other shops throughout the country electric welding is extensively used at the Beech Grove, Ind., shops of the Big Four to expedite car repairs and save both material and labor in many individual repair operations.

In the construction of battery boxes, for example, a saving of approximately 50 lb. weight per box is effected without any sacrifice of strength. The general design of the boxes is evident from the illustration which shows four boxes in various stages of construction. Made of No. 10 gage steel, the various sheets and angles used in the box are assembled in position in a special jig and arc-welded together. The outside seams are welded, using No. 7  $\frac{1}{8}$ -in. coated wire, and then the insides, using No. 5  $\frac{5}{32}$ -in. wire, to speed



Passenger car steps fabricated by a combination of riveting and welding

Battery boxes in process of construction by electric welding at Beech Grove shop



up the operation. The gusset plates are then applied and the Z-bar floor stiffeners, also the angle supports, and the doors last.

Referring to the second illustration, a composite riveted and welded passenger coach step is shown upside down on the coach-shop floor in order to give a better view of the welding on the underneath portion. As indicated, the angles on the step sides are riveted in place. The treads and risers, however, are applied by welding to the angles. The risers are tack-welded to the tread.

Electric welding is also used to great advantage in renewing corroded sections of passenger-car side and roof sheets which would otherwise have to be entirely removed and replaced. Where side sheets are corroded at the connection to the side sills, for example, the sheet is ripped the entire length of the car a distance of about 15 in. above the sill, using a pneumatic hammer and chisel. A new section of sheet is laid out and applied to the car side, the bottom of the patch being riveted to the side sill and the upper edge butt-welded to the old sheet, using No. 7 coated wire. The seam is tack-welded every 4 in. and the intermediate space then filled in. The welded joint is subsequently smoothed with an angle

grinder and the job completed at a fraction of the cost of previous methods.

In making repairs to corroded roof sheets, the defective section is removed by ripping the sheet about 6 in. above the drip molding and applying a patch made of No. 16 gage material. The upper edge of this patch laps



Corroded car roof end sheet cut away ready for patching

under the old roof 2 in. and is held in place for the welding operation by self-tapping screws spaced about 5 in. apart. The lower edge is clamped to the drip molding every 4 in., a space of  $\frac{1}{8}$  in. being left to be filled in by the welding bead. The way in which this is done, as well as the general method of repairing corroded roof corners, is shown in one of the illustrations.



Welding successfully used for making repairs at car roof corners

## Questions and Answers On the AB Brake

51—Q.—*What is the duty of the vent valve and piston?* A.—To vent brake-pipe air to atmosphere during emergency.

52—Q.—*What is the duty of the accelerated-release piston?* To prevent the return of emergency piston to release until a predetermined brake-pipe pressure is restored.

53—Q.—*What is the duty of the spill-over and ball check?* A.—Provides against over-charge of the quick-action chamber.

54—Q.—*What is the duty of the accelerated-release*

and ball check? A.—To provide secondary build up of brake-pipe pressure (after emergency) from the combined auxiliary-reservoir and brake cylinder volumes, when the emergency slide valve moves to accelerated release position.

55—Q.—What is the duty of the inshot piston and valve? A.—Controls the first stage of emergency brake-cylinder pressure development.

56—Q.—What is the duty of the timing valve? A.—Starts the final stage of emergency brake-cylinder development.

57—Q.—For what purpose is the inshot piston volume chamber? A.—Serves to annul controlled brake-cylinder pressure (which prevails in emergency) during a service application, and modifies the controlled build up (in emergency) when service precedes an emergency application.

58—Q.—Name the various choke plugs in the emergency portion and locate them. A.—(1) Spill-over choke in the emergency portion body, in the bushing under the spill-over ball check. (2) Choke in the upper cover, in the port between the chamber above the spill-over valve and the chamber above the strut diaphragm. (3) Vent-piston choke located in the vent-valve piston. (4) Delay choke plug located in the emergency-portion body, access to which can be effected by the removal of a brass pipe plug. (5) Quick-action chamber charging choke located in the charging port in the emergency portion body under the upper cover. (6) Choke located at the flange of the accelerated-release piston cylinder, in the port leading from the slide-valve seat to the chamber back of the accelerated-release piston. (7) Timing choke under the emergency portion cover, in the port which passes the delay-choke plug when the timing valve opens.

59—Q.—What is the size of the opening and duty of the spill-over choke? A.— $\frac{3}{64}$  in. Its duty is to protect against excessive spill-over-valve leakage.

60—Q.—Give the size opening and duty of choke 97a. A.— $\frac{1}{32}$  in. Its duty is to restrict the flow of air to the chamber above the strut diaphragm in case of diaphragm leakage.

61—Q.—Give orifice size and duty of vent-piston choke 109. A.—No. 69 drill (.029 in.). Controls the rate of quick-action-chamber pressure reduction during an emergency application.

62—Q.—What is the size and duty of the delay-choke plug 127? A.— $\frac{3}{32}$  in. Controls the second stage flow

of air to the brake cylinder immediately after the inshot valve closes during an emergency application.

63—Q.—What is the size and duty of quick-action-chamber charging choke 138? A.—No. 73 drill (.024 in.). The duty is to control the quick-action-chamber charging rate.

64—Q.—What is the opening of choke 140 and its duties? A.— $\frac{1}{32}$  in. Serves to protect against excessive leakage past the accelerated-release piston and its seal, and also to prevent "slamming" of the piston to the extreme left by restricting the flow of air displaced by the piston.

65—Q.—How many springs are contained in the emergency portion? A.—Eleven springs.

66—Q.—Name them. A.—(1) Accelerated-release check-valve spring. (2) Spill-over check-valve spring. (3) Diaphragm spring. (4) Vent-valve spring. (5) Inshot piston spring. (6) Inshot check-valve spring. (7) Emergency piston spring. (8) Graduating-valve spring. (9) Return spring. (10) Piston inner spring. (11) Piston outer spring.

67—Q.—It being understood that the purpose of the valve springs is to hold the valves to their seats, define the duties of the other springs mentioned. A.—(1) Diaphragm springs serve to hold the slide valve to its seat when the diaphragm is balanced. (2) Inshot-piston spring resists inshot-piston movement until the brake-cylinder pressure rises to 15 lb. (3) Return spring returns the piston and slide valve to normal release position when brake-pipe and quick-action chamber pressures are equalized. (4) Piston inner spring serves to resist movement of the emergency piston to accelerated release position at the beginning of release after an emergency application. (5) Piston outer spring serves the same purpose.

## Mill Room Machinery Guards

Unusually neat, substantial and attractive mill-room machinery guards are being used at the Beech Grove, Ind., shops of the Big Four, as shown in the illustration. These guards are made primarily of No. 12 gage galvanized wire screen mounted on  $1\frac{1}{4}$ -in. pipe framework rigidly secured to the mill-room floor by means of stove



Well guarded 30-in., single-head planer at the Beech Grove shop mill room

bolts through the pipe flanges. Metal binding for the corners of the guards and various joints, removable covers, etc., consists of No. 16 gage galvanized iron, with a 1½-in. face, subsequently painted black, giving the guards an unusually workmanlike and trim appearance.

The machine illustrated in the foreground is a 30-in. single-head wood planer which may be operated with entire safety by use of the guard shown. All other planers and power-driven machines in the shop are similarly guarded. One guard is placed over each sanding element of the double-disk sanding machine while the other element is being used. The usual cutter and knife guards are provided on all machines. The endless belt sander is guarded at the ends in case the belt should break when anyone is passing. Shapers and band saws are similarly guarded. The use of goggles is required and it is said that no reportable injury has occurred in this mill room in three years.

## Car Shop Tool Room

The tool-checking system at the Denver & Rio Grande Western passenger car shops, Denver, Colo., is perhaps not unique in all particulars, but it does give effective control of the tool situation by the issuance of a limited number of metal checks to each man, to be left at the tool room in exchange for any tools which may be needed in the various shop operations.

As compared to previous more or less hit-or-miss

methods of issuing pneumatic tools, wrenches, drills, taps, electric light extensions, etc., a large saving is realized in that these tools and supplies are now intensively used and not allowed to accumulate and lie idle in the lockers and work boxes of individual shop men. Moreover, the frequent return of these tools to the toolroom permits maintaining a better check on their condition, as defective or worn out tools are replaced by new ones. The number of broken tools is also substantially reduced, as a man who breaks a drill, for example, is required to return the broken parts before a new drill is issued, and after the third experience of this kind, the shop man has to see the general foreman who points out, in a more or less emphatic manner, the cost of tool breakage and endeavors to find out if the man is simply careless or if there are some adverse conditions connected with his particular drilling operation which need to be corrected.

The toolroom is fully equipped with neat metal boxes, trays and lockers in which supplies and hardware for individual cars going through the shop for repairs are kept. In the illustration, for example, hinges, locks and relatively large parts are kept in the upper metal boxes; window fixtures, screws and other small parts are kept in the trays; and various tools and bulky materials are kept in the lockers underneath.

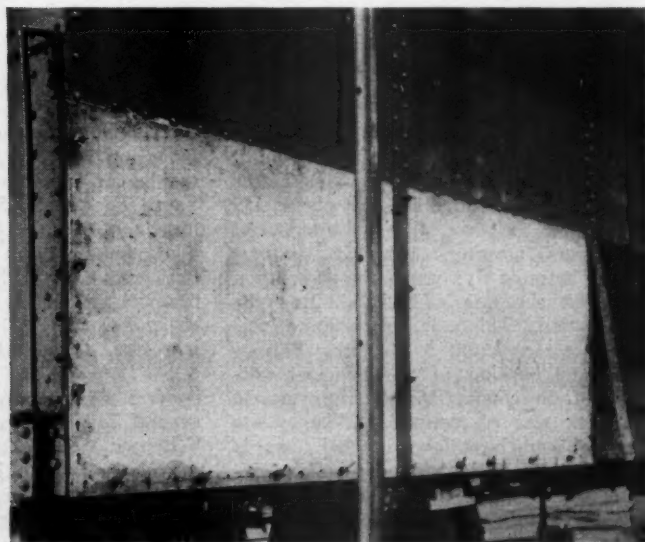
## Repairing Side Sheathing

In cases where the lower side sheathing of steel passenger cars is corroded, repairs are made at the Denver, Colo., shops of the Denver & Rio Grande Western by the application of new steel sheathing strips in place of the corroded sections which have been cut out.

The illustration shows a baggage car in which the defective sheathing has been cut away and new steel installed, fitting up bolts applied to hold the plates in place, and everything made ready for the welding operation at the upper joint. In the case of this particular car, the side sheathing is being renewed from the side sill to the belt rail. Rivets are applied in the side sill and corner post after the welding operation. The weld is ground smooth and, after the final painting operation is performed, the application of the new sheathing can hardly be detected.



Individual metal storage boxes and trays at D. & R. G. W. passenger shop tool room



Corroded section of side sheathing replaced by new steel sheet on D. & R. G. W. baggage car

# Among the Clubs and Associations

**NEW ENGLAND RAILROAD CLUB.**—Col. J. T. Loree vice-president and general manager of the Delaware & Hudson, will be the guest speaker at the October 13 meeting which will be held at the Hotel Touraine, Boston, Mass., at 6:30 p.m.

**INTERNATIONAL ACETYLENE ASSOCIATION.**—The thirty-seventh annual convention of the International Acetylene Association will be held on November 18, 19 and 20 at the Jefferson Hotel, St. Louis, Mo. Technical sessions featuring the oxyacetylene process for welding metals will be held each afternoon and on two evenings. Wednesday evening, November 18, will be devoted to a forum on welding and cutting, and the evening session on Thursday, November 19, is intended to comprise a series of round-table discussions on oxyacetylene welding and cutting practices.

**NEW YORK RAILROAD CLUB.**—The first fall meeting of the New York Railroad Club will be held on Friday evening, October 16, at 7:45 p.m. at the club's usual meeting place—the auditorium of the Engineering Societies building, 29 West Thirty-ninth street, New York. The subject for discussion will be the New York, New Haven & Hartford train which was converted by the Edward G. Budd Manufacturing Company from two old steel coaches, and equipped with the Besler steam power plant. George D. Besler will show pictures of, and describe the power plant; a representative of the Budd company will discuss the modernization of the train, while a representative of the New Haven will tell something about the inception of the idea.

## Master Boiler Makers Meet at Chicago

The twenty-third annual meeting of the Master Boiler Makers' Association, held at the Hotel Sherman, Chicago, September 16 and 17, was attended by about 175 members of the association and guests. At the business meeting a year ago, the first after a lapse of five years, the association undertook the task of rehabilitating the organization. This year, the results of this effort were apparent in the increased interest and backing of the principal railroads of the country, practically everyone of which was represented. ¶The efforts of the officers have been directed towards a complete modernization of the association. To this end, the by-laws were revised in a manner to make possible the most efficient handling of association affairs in the future. Henceforth, the officers to be elected will include a president,

secretary-treasurer and an executive board of nine members. This board will elect one of its members as vice-president of the association, who will also serve as chairman of the board. To be eligible for the office of president or vice-president, a member must have had at least one year's experience on the executive board. ¶One of the principal features of the meeting was an address on the aims of the Bureau of Locomotive Inspection, which was delivered by John B. Brown, assistant chief inspector of the bureau. A special paper, contributed by the research committee of the International Acetylene Association, on the subject "Applications of Oxy-Acetylene Welding and Cutting in Locomotive Boiler Upkeep and Repairs," was presented by the chairman of the committee, C. W. Obert. ¶Special committee reports covering various phases of locomotive boiler work were presented and discussed widely by the membership. The subjects and personnel of the committees follow: "Boiler and Tender Pitting and Corrosion." Committee: J. L. Callahan, special representative, National Aluminate Corporation (formerly general boiler inspector, Chicago Great Western), chairman; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific; J. P. Powers, system general boiler foreman, Chicago & North Western. ¶"Proper Brick Arch Setting in Locomotive Fireboxes." Committee: E. E. Owens, general boiler inspector, Union Pacific, chairman; B. G. King, assistant general boiler inspector, Northern Pacific; H. A. Bell, general boiler inspector, Chicago, Burlington & Quincy; C. F. Totterer, general boiler foreman, Alton. ¶"Autogenous Welding as Applied to Locomotive Boilers and Tenders." Committee: Albert F. Stiglmeier, boiler foreman, West Albany Locomotive Shops, New York Central, chairman; John A. Doarnberger, master boiler maker, Norfolk & Western; S. Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford; H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe; G. E. Stevens, general boiler inspector, Boston & Maine. ¶"Proper Thickness of Front Tube Sheets." Committee: Walter R. Hedeman, assistant mechanical engineer, Baltimore & Ohio, chairman; C. A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis; E. C. Umlauf, supervisor of boilers, Erie Railroad; R. A. Pearson, general boiler inspector, Canadian Pacific. ¶"Proper Methods of Applying All Types of Staybolts to All Types of Boilers." Committee: Leonard C. Ruber, superintendent boiler department, Baldwin Locomotive Works, chairman; George M. Wilson, general boiler supervisor, American Locomotive Company; M. V. Milton, chief

boiler inspector, Canadian National; C. W. Buffington, general master boiler maker, Chesapeake & Ohio. ¶"Improvements in Locomotive Front Ends." Committee: J. M. Stoner, supervisor of boilers, New York Central Lines West, chairman; E. M. Cooper, district boiler inspector, Baltimore & Ohio; H. E. May, general boiler and locomotive inspector, Illinois Central; G. L. Young, boiler foreman, Reading.

## ELECTION OF OFFICERS

The annual election resulted in the following officers being selected for the ensuing year: President: M. V. Milton, chief boiler inspector, Canadian National, Toronto, Ont., Can. Secretary-Treasurer: Albert F. Stiglmeier, general foreman boiler maker, New York Central, Albany, N. Y. ¶Executive Board (one year): George L. Young, foreman boiler maker, Reading, Reading, Pa.; C. W. Buffington, general master boiler maker, Chesapeake & Ohio, Richmond, Va.; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific, Minneapolis, Minn. ¶(Two years): M. V. Milton, chief boiler inspector, Canadian National, Toronto, Ont., Can.; Charles J. Klein, locomotive inspector, Bureau of Locomotive Inspection, Albany, N. Y.; Sigurd Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford, East Milton, Mass. ¶(Three years): William N. Moore, general boiler foreman, Pere Marquette, Grand Rapids, Mich.; Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis, Indianapolis, Ind.; E. C. Umlauf, supervisor of boilers, Erie, Susquehanna, Pa.

## Fuel and Traveling Engineers' Associations Unite

In the interests of economy and increased effectiveness, as well as to meet the wishes of higher railway officers, the International Railway Fuel Association, organized 27 years ago, and the Traveling Engineers' Association, which has been functioning for 44 years, have united to form a single association known as the Railway Fuel and Traveling Engineers' Association. The announced objective of the new association is "to improve the locomotive service and the use of fuel on all railroads," and it was formally organized at joint business meetings of the two associations held at the Hotel Sherman, Chicago, September 15 to 18, inclusive. ¶The work of actually merging the two associations was performed by a special committee of 12 men from each, duly authorized to effect the consolidation, elect temporary officers, appoint committees and conduct the affairs of the association during the current year. International Rail-

way Fuel Association members elected to represent the association on this special joint committee included: C. I. Evans, M-K-T, president; J. D. Clark, C. & O.; A. A. Raymond, N. Y. C.; R. Collet, St. L-S. F.; J. R. Jackson, M. P.; E. G. Sanders, A. T. & S. F.; C. N. Page, L. V.; L. E. Dix, T. & P.; M. F. Brown, N. P.; G. H. Likert, U. P.; J. E. Davenport, N. Y. C., and Secretary-Treasurer T. Duff Smith. The Traveling Engineers' Association elected as its representatives on the special committee M. A. Daly, N. P., president; J. M. Nicholson, A. T. & S. F.; Ralph Hammond, N. Y. N. H. & H.; G. M. Boh, Erie; W. C. Shove, N. Y. N. H. & H.; J. C. Lewis, R. F. & P.; J. J. Kane, L. V.; C. C. Hipkins, Penna.; A. E. Johnson, C. M. St. P. & P.; W. H. Davies, Wabash, and F. P. Roesch, Standard Stoker Company. ¶At the first meeting of the joint committee, presided over by F. P. Roesch, the following officers were elected to conduct the affairs of the association during the coming year, which includes presiding at the 1937 meeting: Chairman, J. D. Clark; Vice-Chairman, C. I. Evans; Vice-Chairman, A. T. Pfeiffer; Vice-Chairman, F. P. Roesch; Secretary-Treasurer, T. Duff Smith, the latter having offices at 1660 Old Colony building, Chicago. The following committees were appointed: Committee on Constitution and By-Laws—R. Collett, J. R. Jackson, M. A. Daly, J. E. Davenport and L. E. Dix; Committee on Committees—A. A. Raymond, G. H. Likert, W. C. Shove, G. M. Boh and C. C. Hipkins; Committee on Audit and Transfer—T. Duff Smith, C. N. Page and F. P. Roesch; Committees on Subjects for the 1937 Annual Meeting—J. M. Nicholson, A. T. Pfeiffer, M. F. Brown, W. H. Davies, J. C. Lewis and R. Hammond. ¶During the course of the meetings of the two associations, at which there was a total registration of approximately 300, numerous informative reports were presented for consideration. The Traveling Engineers' Association discussed the function of the traveling engineer, what has been accomplished by extending locomotive runs, brakes on high-speed trains, and high-speed passenger locomotives. ¶In addition to receiving the usual standing committee reports on fuel economy devices, stationary boilers, firing practice, fuel stations, etc., the International Fuel Association was addressed by C. F. Richardson, president of the West Kentucky Coal Company, and by Lewis Ware, president of the United Electric Coal Company.

### General Foremen Elect Officers

Three subjects, or committee reports, were presented at the thirtieth annual meeting of the International Railway General Foremen's Association held September 15 and 16 at the Hotel Sherman, Chicago. The meeting was presided over by President A. H. Keys, district master car builder, Baltimore & Ohio, Pittsburgh, Pa., and the subjects considered were Maintenance of Diesel Locomotives, Production Methods in Locomotive Repairs and Maintenance of High-Speed Passenger Equipment. ¶At the close of the business session, the following officers were

elected for the ensuing year: President, F. T. James, general foreman, Delaware, Lackawanna & Western, East Orange, N. J.; First Vice-President, F. B. Downey, general foreman, Chesapeake & Ohio, Huntington, W. Va.; Second Vice-President, J. Oxley, general car foreman, Chicago & North Western, Chicago; Third Vice-President, Charles C. Kirkhuff, general foreman, Atchison, Topeka & Santa Fe, Chicago; Secretary-Treasurer, William Hall, Winona, Minn.

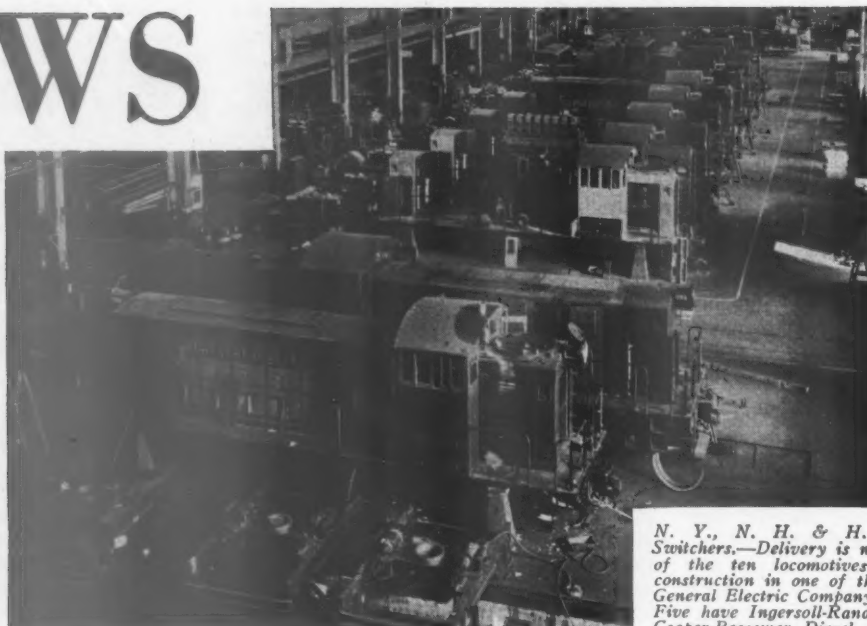
## Club Papers

### Why Federal Inspection?

*Central Railway Club.*—Meeting held September 10 at Buffalo, N. Y. Address by John M. Hall, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission. ¶In his address under the above title, Mr. Hall reviewed the results of 25 years of locomotive inspection by the federal government and the reasons which led to the enactment of the laws regulating the condition of locomotives operating in interstate commerce. The first of these was the Ash Pan Act, which became effective January 1, 1910. It was followed by the Boiler Inspection Act, which became effective July 1, 1911. This act was extended to include the entire steam locomotive and tender by amendment which became law on March 4, 1915, and was further extended to include locomotives propelled by other power than steam by amendment which became law on June 1, 1924. In developing the reasons for the enactment of these laws Mr. Hall quoted extensively from the testimony presented in the hearings before the committees of Congress during the years preceding the final passage of the Act and its amendments. ¶In his introductory remarks Mr. Hall said: "Our purpose in investigating accidents is not mere curiosity, but is for the purpose of preventing reoccurrences of similar mishaps. The matter of boiler explosions, which I shall show you, have been reduced 90 per cent during the 25 years this law has been in force. We go into these accidents very, very thoroughly. We are human. We have a human interest in those that have gone and left sorrowing ones behind. We also have a very human interest in those who are crippled—perhaps for life. ¶"In investigating what we term 'crown sheet accidents' there are infallible indications that point out to us if the particular accident was due to low water. I want to prove to you that we do carefully investigate all such accidents. We never go to an accident with our mind made up. We investigated such accidents in the early years of the law and one or two not so very long ago that were not due primarily to low water, but due to bad water. Let me tell you the difference briefly. ¶"In a legitimate case of low water your crown sheet is overheated uniformly. The extent of overheating depends on the height of the water, or, in other words, how low the water has become and the part of the firebox sheets that are uncovered and exposed to the terrific heat from the fire. The more intense the heat and the lower

the water, the bluer the color. In many cases there is almost always a gray line, or what we call the low-water line, plainly visible. ¶"We have investigated accidents caused by improper conditions that possibly 25 years ago would have been called low-water cases—man-failures. There was no one to contradict, because there was no federal investigation. I do not mean to imply that mechanical officials were dishonest, but I do say they had to do some things before the Boiler Inspection Law that they did not want to do; in other words, they frequently went to the scene of the accident with their minds made up. ¶"There is a decided difference in the indications of a boiler explosion when such explosions are due to low water than, for instance, an accident due to mud or scale adhering to the crown and other firebox sheets, in the latter cases the crown sheet will only show overheating at such places where the mud or scale had been, and almost invariably the overheating will be in areas perhaps 24 in. in diameter or larger or smaller spots, as the case may be, while in cases of low water the highest portion of the crown sheet will usually show uniform overheating. ¶"If there are defective crown-stay or firebox sheets that cause or contribute to the accident, we can find the evidence of such defective conditions and they are plainly covered in our accident reports. There is a difference between an actual low-water case and a case of overheating due to scale or mud. ¶"We have had cases where the boiler explosion was due to bad water. In that case almost invariably you will find the side sheets of the firebox a deeper blue than the crown sheet itself, and, as you know, the crown sheet is the highest part of the firebox. In that case you will find the overheating is spotty. There may be two or more places on the crown sheet that will indicate the lack of water and down on the side sheets you will find that same indication. ¶"I want you to know that our purpose in investigating accidents is not to 'hang' it onto anybody. We do not put anybody in jail. We do not penalize the individual, nor do we penalize the railroads, unless we find the water glass stopped up, injectors inoperative or other defective conditions. We have had some cases of this kind where the tubular type of water glass was carelessly applied—sometimes the glass was too short and the rubber gasket, due to heat, will shrivel and close one end or another of the water glass, which will result in a false indication of water. I remember we investigated an unmistakably low water case some years ago. The water glass was standing half full of water when we made our investigation because the bottom of the water glass was plugged solid with a rubber gasket." ¶The results of federal inspection are shown by the following facts pointed out by Mr. Hall: Accidents to boilers and appurtenances declined from 856 in the first year, ended June 30, 1912, to 74 during the year ended June 30, 1936. The killed declined from 91 to 10, and the injured from 1,005 to 79 during the same period. Machinery accidents since 1917 have decreased 40 per cent; the number killed, 30 per cent, and the number injured, 49 per cent.

# NEWS



*N. Y., N. H. & H. Diesel-Electric Switchers.—Delivery is now being made of the ten locomotives shown under construction in one of the shops of the General Electric Company at Erie, Pa.—Five have Ingersoll-Rand and five have Cooper-Bessemer Diesel engines*

## Denver Zephyrs Complete 200,000 Miles

THE Advance Denver Zephyrs of the Chicago, Burlington & Quincy, which were placed in service on a 16-hour schedule between Chicago and Denver, Colo., on May 31, completed 200,000 miles on September 5. During this 97-day period, the Advance Zephyrs were late only four times. The schedule calls for an average of 65 miles an hour. A total of 14,669 passengers was carried on the 194 trips.

## Improvement Programs

THE Elgin, Joliet & Eastern will repair 300 box cars in its own shops.

The federal district court at St. Louis, Mo., has authorized the trustee of the Missouri Pacific to install Evans automobile loading devices in 150 additional box cars, and to modernize 208 cars, already equipped with such devices, by the installation of parts that will permit the loading of late model automobiles. The work will cost \$180,850.

## C. R. I. & P. Awards Contract for Shop Building

THE Chicago, Rock Island & Pacific has awarded a contract to A. H. Newman, Des Moines, Iowa, for the construction of an 80-ft. by 120-ft. shop building at East Des Moines and an 11-stall addition to its enginehouse at the same point, at a total cost of about \$125,000. The shop building will be of brick construction with a timber roof carried on steel trusses, while the enginehouse extension, also of brick construction, will have a frame roof.

## Smoke Prevention Manual

THE Smoke Prevention Association has issued an 82-page illustrated "Manual of Smoke and Boiler Ordinances" which not only lists the local smoke abatement boards

and requirements in various cities throughout the United States, but also contains much useful information regarding how to secure more efficient combustion and hence a reduction of the smoke nuisance. The book contains a Ringleman chart for grading smoke density, a code for rating heating boilers, a table of head room requirements for smokeless boiler settings, and excerpts from papers presented at recent conventions of the Smoke Prevention Association. This book, which is valuable for reference purposes, may be secured by writing to the executive offices of the association, City Hall Square building, Chicago.

## P.R.R. Research Activities

How the Pennsylvania, through research and experimentation, utilizes the advances of science, new inventions and improved technical processes for the improvement of its freight and passenger service is told in a special report which has recently been made public.

While it points out that the Pennsylvania has conducted research practically from its inception, the report deals most fully with nine outstanding projects recently completed or still under way, among which are:

1. Special electric locomotive tests at Claymont, Del., over a section of track equipped with instruments to measure the pressures and stresses of locomotive wheels on the rails.
2. Development of the streamline contours of the new electric and steam locomotives through wind tunnel tests, in which, for the first time, clay models capable of immediate alteration in shape were used.
4. Locomotive road tests over various sections of the system, using electrically-operated instruments which recorded on a photographic film the forces exerted at the axles and elsewhere on the locomotives at various speeds.

6. Extensive research in air-conditioning passenger cars, producing improved apparatus and a scientific scale of differentials between interior and exterior temperatures for maximum health and comfort.

7. The development of a new spring arrangement for freight cars to prevent excessive vertical movements of the car body and protect the contents from damage.

In 1874 the Pennsylvania established a department of physical tests at its Altoona, Pa., shops, followed by a chemical laboratory in 1875 and a bacteriological laboratory in 1889. These were the first test plants of their kind developed by any railroad. Since 1905 a locomotive test plant has been an important feature of the research equipment.

## L.C.L. Refrigerator Container Being Developed

AN L.C.L. refrigerator container, which can be picked up and delivered by truck and be transported by railroad in a standard 40-ft. box car, is being tested by the Universal Carloading & Distributing Company, Chicago. The outstanding feature of the container is its lightness, its total weight being 550 lb., and its load capacity 210 cu. ft. The container, which is being constructed by the Sterling Lumber Company, Chicago, is made of wood, and has bunkers for 150 lb. of dry ice, enough to carry shipments through four days' transit without re-icing. The containers are insulated with Silvercote, a product of Silvercote Products, Inc. The containers also have electrical connections for the pre-heating of interiors for perishable movement during winter weather. The containers have a side dimension of seven by seven feet and front and back dimension of five by seven feet. Six can be loaded in a standard 40-ft. box car.

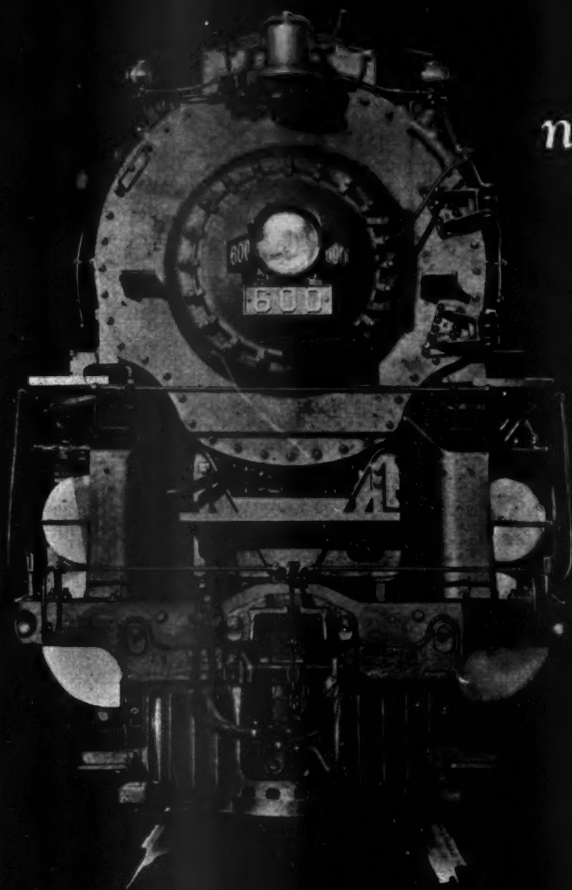
Because of the ease with which the containers can be handled on dollies the Universal Carloading & Distributing Company plans to purchase 100 of these containers.

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# MODERN POWER

*costs less  
to operate*

*increases  
net earnings*



If modern power merely moved trains faster so more trains could use the rails, its purchase, in many cases, would be more than justified . . . However, in addition modern power moves bigger trains at lower ton-mile costs and also shows a surprising saving in locomotive maintenance . . . Modern Power increases railroad net earnings.

LIMA LOCOMOTIVE WORKS

INCORPORATED, LIMA, OHIO



# Supply Trade Notes

R. B. NICHOLS, manager of the Chicago office of the Bantam Ball Bearing Company, has been promoted to manager of the Industrial Bearing division.

HOYLE JONES, formerly president of the Superior Tube Company, has been appointed district sales manager of the Republic Steel Corporation, with headquarters in Tulsa, Okla.

FREDERICK O. SCHRAMM has been appointed district sales agent for New York and vicinity of the Pittsburgh Steel Foundry Corporation, Glassport, Pa. Mr. Schramm's headquarters are at 11 West 42nd street, New York City.

THE TIMKEN STEEL & TUBE COMPANY'S New York office, in charge of Arthur R. Adelberg, district manager, is now located at 165 Broadway. Mr. Adelberg formerly had his office in the Timken Roller Bearing Company offices at 16 West 60th street.

GEORGE W. NORRIS, Philadelphia, Pa., former governor of the Federal Reserve Bank of Philadelphia, and Matthew S. Sloan, New York, chairman of the board and president of the Missouri-Kansas-Texas, have been elected directors of the Edward G. Budd Manufacturing Company, Philadelphia, to fill vacancies on the board. Mr. Norris also was elected chairman of the finance committee, consisting also of Mr. Sloan and W. W. Colpitts, of New York.

THE CARNEGIE-ILLINOIS STEEL CORPORATION, a subsidiary of the United States Steel Corporation, has adopted a new trade name, USS CARILLOY, to identify the entire group of alloy steels previously marketed as Carnegie-Illinois alloy steels.

GEORGE I. WRIGHT has been appointed manager transportation department of the Westinghouse Electric & Manufacturing Company, with headquarters at East Pittsburgh, Pa. He has charge of engineering and sales of equipment supplied to the transportation industry.

HERBERT A. MAY has resigned as vice-president of the Safety Car Heating & Lighting Company to become vice-president of the Union Switch & Signal Company, with headquarters in Pittsburgh, Pa. Mr. May will retain his interest in the Safety Car Heating & Lighting Company, of which company he will continue as a director.

JAMES S. HEARONS has been appointed assistant manager of sales, Railroad division of the Inland Steel Company, Chicago. Peter M. Lorenz has been appointed district sales manager and Frederick A. Ernst has been appointed assistant manager of the St. Louis office. Mr. Hearons attended school in the East, and began work as a special apprentice on the Erie in 1906, and later became associated with the Illinois Central. During the World War he served in the A. E. F. as

captain in the Engineering division. Prior to his Inland appointment, Mr. Hearons was assistant to the president of the Clark Equipment Company, specializing on railroad sales.

ARTHUR T. HERR has been appointed vice-president in charge of sales of the Union Railway Equipment Company, Chicago, in the territory adjacent to Den-



Arthur T. Herr

ver, Colo., with headquarters in the Equitable building, Denver. Mr. Herr began his career with the Westinghouse Air Brake Company at Pittsburgh, Pa., and in 1916 organized the A. T. Herr Supply Company at Denver, which company he will continue to head.

WILLIAM E. CORRIGAN, assistant vice-president, has been elected vice-president of the American Locomotive Company, Railway Steel Spring Division, with headquarters at New York. Mr. Corrigan, who entered the service of the American Locomotive Company in 1909, is



William E. Corrigan

a graduate of the four-year course in locomotive construction which the company conducts in its engineering department at  
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## New Equipment

LOCOMOTIVE ORDERS			
Road	No. of locos.	Type of loco.	Builder
Aliquippa & Southern.....	1 <sup>1</sup>	0-8-0	American Locomotive Co.
Birmingham & Southern.....	5	900-hp. Diesel-elec.	American Locomotive Co.
Green Bay & Western.....	6 <sup>2</sup>	4-8-4	American Locomotive Co.
Toledo, Peoria & Western.....	6	4-8-4	American Locomotive Co.
United Fruit Co.....	5 <sup>3</sup>	2-8-2	Baldwin Locomotive Works
LOCOMOTIVE INQUIRIES			
Detroit & Toledo Shore Line.....	3	2-8-2	.....
Great Southern Lumber Co.....	1	2-8-2	.....
Kansas City Southern.....	10	2-10-4	.....
St. Louis-Southwestern.....	5	4-8-4	.....
FREIGHT CAR ORDERS			
Road	No. of cars	Type of car	Builder
Boston & Maine.....	750	50-ton gondolas	Bethlehem Steel Co.
Maine Central.....	500	Box	Magor Car Corp.
	100	Gondolas	Bethlehem Steel Co.
	150	Twin hopper	
Missouri Pacific.....	200	40-ton box	
Union R. R.....	100	70-ton gondolas	Mt. Vernon Car Mfg. Co.
			Ralston Steel Car Co.
FREIGHT CAR INQUIRIES			
Kansas City Southern.....	750	50-ton box	.....
	200	70-ton box	.....
PASSENGER CAR ORDERS			
Road	No. of cars	Type of car	Builder
New York Central.....	2 <sup>4</sup>	Coaches	Company shops
PASSENGER CAR INQUIRIES			
C. & E. I.....	2	Rail motor, with pass. and mail compart.	.....
C. & N. W.....	2 <sup>5</sup>	7-car trains	.....

<sup>1</sup> This locomotive will have 25-in. by 28-in. cylinders and a total weight in working order of 231,000 lb.

<sup>2</sup> These locomotives will have 23½ in. by 30 in. cylinders and a total weight in working order of 365,000 lb.

<sup>3</sup> For service in Guatemala.

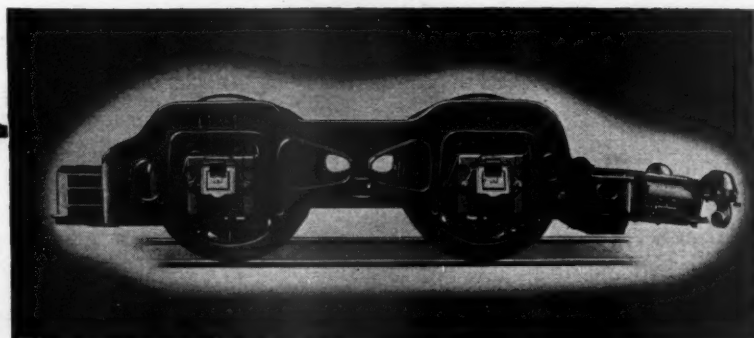
<sup>4</sup> Equipment to be assigned to New Orleans, Texas & Mexico.

<sup>5</sup> For "The Mercury." To be similar to those now in service on the train between Cleveland, Ohio, and Detroit, Mich.

<sup>6</sup> The inquiry is issued to ascertain comparative costs rather than with a view to immediate purchase. Each train to include one combination parlor-bar-lounge car, 2 first class coaches, 1 dining car, 1 lounge-parlor car, 1 parlor car and 1 parlor-drawing room-observation car, of light-weight alloy steel.



## THIS NEW MODERN POWER FOR THE LOUISIANA & ARKANSAS INCORPORATES THE LOCOMOTIVE BOOSTER



The Locomotive Booster

On the new Mikado Type Locomotives recently delivered by Lima Locomotive Works, Incorporated, to the Louisiana & Arkansas Railway the Locomotive Booster is incorporated as an integral part of the design.

This modern power carries 240 pounds boiler pressure and develops a starting tractive effort of 71,300 pounds of which the Booster delivers 16,500 pounds.

In any locomotive the Booster improves operation by quicker acceleration and smoother starting. It materially reduces maintenance costs by avoiding excessive starting stresses that cause undue shock and wear.

Modern power is Booster power.



The Franklin 8 Butterfly Type Firedoor increases the efficiency of locomotive firing.



When maintenance is required a replacement part assumes importance equal to that of the device itself and should be purchased with equal care. Use only genuine Franklin repair parts in Franklin equipment.

# FRANKLIN RAILWAY SUPPLY COMPANY, INC.

NEW YORK

CHICAGO

MONTREAL

Schenectady, N. Y. From May, 1913, Mr. Corrigan served in various capacities in the drawing office at Schenectady until 1915, when he was transferred to the Cooke plant, Paterson, N. J., where he was engaged in elevation work and general calculating. He remained in that position until November, 1917, when he entered the United States Army, where he served consecutively as second lieutenant, first lieutenant and captain in the artillery ordnance branch, field service, in charge of plant production at several gun carriage and ammunition plants. Following the armistice, he served as secretary and then ordnance district chief and chairman of the claims board in charge of the settlement of claims arising out of the cancellation of war contracts between the government and various manufacturers. He re-entered the employ of the American Locomotive Company in 1920, serving for two years in the sales department at New York. He was then transferred to Chicago as salesman for Alco accessories in the middle western territory. In 1923 he was appointed general sales representative of the company on the Pacific Coast, with the title of district sales manager; in 1930 he became district sales manager at Cleveland, and in January, 1935, was appointed assistant vice-president of the American Locomotive Company, Railway Steel Spring Division.

VICTOR W. ELLET, vice-president of the Hunt-Spiller Manufacturing Corporation, Boston, Mass., has been elected president and general manager and Elbert J. Fuller, sales manager, has been elected vice-president. Mr. Ellet was born on



Victor W. Ellet

June 11, 1880, at Burlington, Iowa. In 1886 his parents moved to Fort Madison, Iowa, where he was educated in the public schools, and Johnson's Business College. He later took the railroad engineering course in the International Correspondence School. He served his apprenticeship as a machinist with the Atchison, Topeka & Santa Fe at Fort Madison, completing the apprenticeship in 1901. After this time he worked for the St. Louis, Iron Mountain & Southern (Missouri Pacific), Fort Worth & Denver City, and the old Choc-taw, Oklahoma & Gulf, now a part of the Chicago, Rock Island & Pacific, returning later to the Santa Fe at Fort Madison. He also served as expert tool maker in the United States arsenal at Rock Island, Ill.

In 1905 he returned to railroad service as mechanical foreman on the Missouri Pacific at Hoisington, Kan. The following year he entered the service of the Chicago, Rock Island & Pacific as an executive in the mechanical departments at Valley Junction, Iowa; Fairbury, Neb.; Chicago, and Rock Island, Ill. In 1911 he entered the employ of Hunt-Spiller Manufacturing Corporation as mechanical representative. He was appointed sales manager in 1925, and vice-president in 1928. He now becomes president and general manager, succeeding the late John G. Platt. Mr. Ellet is a member of the executive committee of the Railway Supply Manufacturers Association, and a member of a number of railroad and engineering clubs.

Elbert J. Fuller was born in 1883 at Clinton, Iowa, where he was educated in



(c) Bachrach

Elbert J. Fuller

the public schools. At an early age he entered the service of the Chicago & North Western as a machinist apprentice at Clinton. After completing his apprenticeship and serving as a machinist at Clinton, he was promoted to a supervisory position in the mechanical department. During the years 1911, 1912 and 1913 he was chief inspector of new equipment for the Chicago & North Western at the works of the American Locomotive Company, Schenectady, N. Y. He left railroad service on April 1, 1914, to enter the employ of the Hunt-Spiller Manufacturing Corporation. He served as mechanical representative until his appointment as assistant sales manager October 1, 1927, holding this position until March 21, 1928, when he became sales manager. In addition to his present capacity as vice-president, Mr. Fuller has been appointed sales manager.

J. E. BUCKINGHAM has been elected vice-president in charge of sales for the Western district of the Lincoln Electric Railway Sales Company, with headquarters in the Straus building, 310 South Michigan avenue, Chicago. Mr. Buckingham began his railroad career in 1900 with the Union Pacific System at Salt Lake City, Utah, and Omaha, Neb. Eight years later he became master mechanic of the Union Stock Yards Company and still later was superintendent of the Motor and Refrigerator Division of Wells Fargo Express. He also has had experience in the

railroad departments of the Baldwin Locomotive Works, the Standard Steel Company, and the Associated Oil Company. For the past 14 years he has been employed in the Railroad Sales Division of the Worthington Pump & Machinery Corporation, for the last five years being western regional manager, Railroad Division. During the war Mr. Buckingham was an officer in the Railroad Unit, U. S. Army, Company D, 87th Engineers.

JOSEPH DAVIS, executive vice-president of the American Locomotive Company, on account of ill health, tendered his resignation, which was accepted on September 24. David Dasso was appointed vice-president of the Diesel-Engine Division with headquarters in New York, succeeding R. B. McColl, who has resigned to become president of Alco Products, Inc., a subsidiary of the American Locomotive Company. Mr. Davis also resigned as a director, member of the executive committee and president of Alco Products, Inc., division of the American Locomotive Company. Mr. McColl, in addition to being president, was appointed a director, and member of the executive committee of Alco Products, Inc., to succeed Mr. Davis.

E. M. HARSHBARGER, who has been connected with the railway division of SKF Industries, Inc., since early in 1927, has been appointed manager of railway sales,



E. M. Harshbarger

with headquarters at the home office of the company, Philadelphia, Pa. Mr. Harshbarger attended Purdue University and for several years prior to joining SKF Industries, Inc., was affiliated with S. F. Bowser & Company, Fort Wayne, Ind.

FREDERIC E. LYFORD has been appointed assistant to Robert S. Binkerd, vice-president of the Baldwin Locomotive Works. Mr. Lyford, since February, 1934, has served as an examiner for the Railroad Division of the Reconstruction Finance Corporation, which position he resigned to join the Baldwin organization. He was born on January 20, 1895, and was graduated in mechanical engineering from Cornell University. After a year in the service of a shipbuilding concern and a machine tool company, he entered the army, serving in the field artillery and in the air service in France as first lieutenant. In 1919, he became an assistant sales

manager of the Allied Machinery Company of America, resigning the following year to engage in advertising and sales promotion work for a milling company at Waverly, N. Y. In 1923 he entered the service of the Lehigh Valley as apprentice instructor, in connection with which he also directed classes for the instruction of



F. E. Lyford

mechanical department foremen. Subsequently, he served three years as assistant general machine foreman at the Sayre locomotive shops of the Lehigh Valley, during which period he also handled engineering problems for the shop superintendent. Later, Mr. Lyford was promoted to the position of special engineer to the executive vice-president, making studies of a wide variety of mechanical department subjects, including water treatment, locomotive lubrication and the design and economy of new power. In February, 1934, he left the Lehigh Valley to become an examiner for the Railroad division of the Reconstruction Finance Corporation.

EVERETT CHAPMAN, vice-president of Lukenweld, Inc., Coatesville, Pa., has been elected president to succeed G. Donald Spackman, who has been appointed general superintendent of the Lukens Steel Company. Robert J. Whiting, superintendent of Lukenweld, Inc., in charge of



Everett Chapman

all manufacturing, has been elected vice-president of Lukenweld.

Everett Chapman was born in Detroit, Mich., on May 9, 1901. He attended grade

school and high school at Detroit and was later employed by the Detroit Testing Laboratories. In 1919 he entered the University of Michigan, where he obtained the degree of bachelor of science in electrical engineering in 1923. After a year's graduate work in physics, his senior thesis on electrical vibration of high frequencies having gained for him the degree of master of science, he became an instructor in electrical engineering at Purdue University. In 1925 he joined the Lincoln Electric Company, Cleveland, Ohio, as an experimental engineer. In 1930 he became director of development and research of Lukenweld, Inc., of which company he was elected vice-president early in 1934.

Robert J. Whiting, vice-president of Lukenweld, was born in 1885 at Foster, Pa. He attended grade school, high school and business college at Scranton, and in 1906 obtained employment with the Keller Manufacturing Company, Scranton, vehicle manufacturers. In 1909 he entered the service of the Pickering Engineering Company, Hartford, Conn., where he was engaged principally in problems of structural design concerned with power-plant equip-



R. J. Whiting

ment. In 1913 he became master mechanic on plant equipment for the Ford Motor Company, Detroit, later being appointed superintendent of body construction at the Ford plant. During the war he was in charge of the men employed at the Ford Motor Company for the construction of boats for the United States Navy. In 1923 he became production engineer for the Fisher Body Corporation, and for 4½ years was manager of Fisher's Flint, Mich., unit No. 1. In May, 1934, Mr. Whiting resigned to become superintendent of Lukenweld, Inc.

#### Obituary

HARRY ORVILLE FETTINGER, New York railroad representative of the Ashton Valve Company, Boston, Mass., died on August 20 of a heart ailment after a long illness, at his home in Roselle, N. J., at the age of 67 years. Mr. Fettinger was born at Altoona, Pa., and began work in 1887 as machinist apprentice in the Altoona machine shops of the Pennsylvania, later serving consecutively as journeyman machinist, inspector in the office of superintendent of motive power and inspector

in the office of general superintendent of motive power. From 1904 until 1906, he was air brake and steam heat inspector, then chief air brake and steam heat inspector of the Pennsylvania System; later in the same year he entered the supply business. From 1906 to 1911 he was a salesman in the railroad department of the



H. O. Fettinger

Johns-Manville Corporation, then to 1914 he was a representative of the Safety Car Heating & Lighting Company. In 1914 he entered the service of the Ashton Valve Company and for 22 years served as manager of its railroad department in New York. In addition to his membership in technical organizations Mr. Fettinger was interested in civic affairs, having served as president of the board of education of his home town.

O. H. MELLUM, assistant vice-president of the American Car and Foundry Company, with headquarters at Chicago, who was killed in Lake Bluff, Ill., on August 14, by a freight train while alighting from another train at that station, was born in 1890. Mr. Mellum entered the employ of the American Car and Foundry Company in 1904 as an office boy and messenger.



(c) Moffett Studio

O. H. Mellum

After serving in various capacities, Mr. Mellum was appointed sales agent at Chicago, and in February, 1930, was promoted to assistant vice-president.

(Turn to second left-hand page)



# STRAIGHT LINE

The controlled atmosphere bright annealing furnace which normalizes ELECTRUNITE Boiler Tubes at a temperature above 1650° F. without producing scale discharges automatically, as shown above, into the boiler tube finishing building shown at the right.

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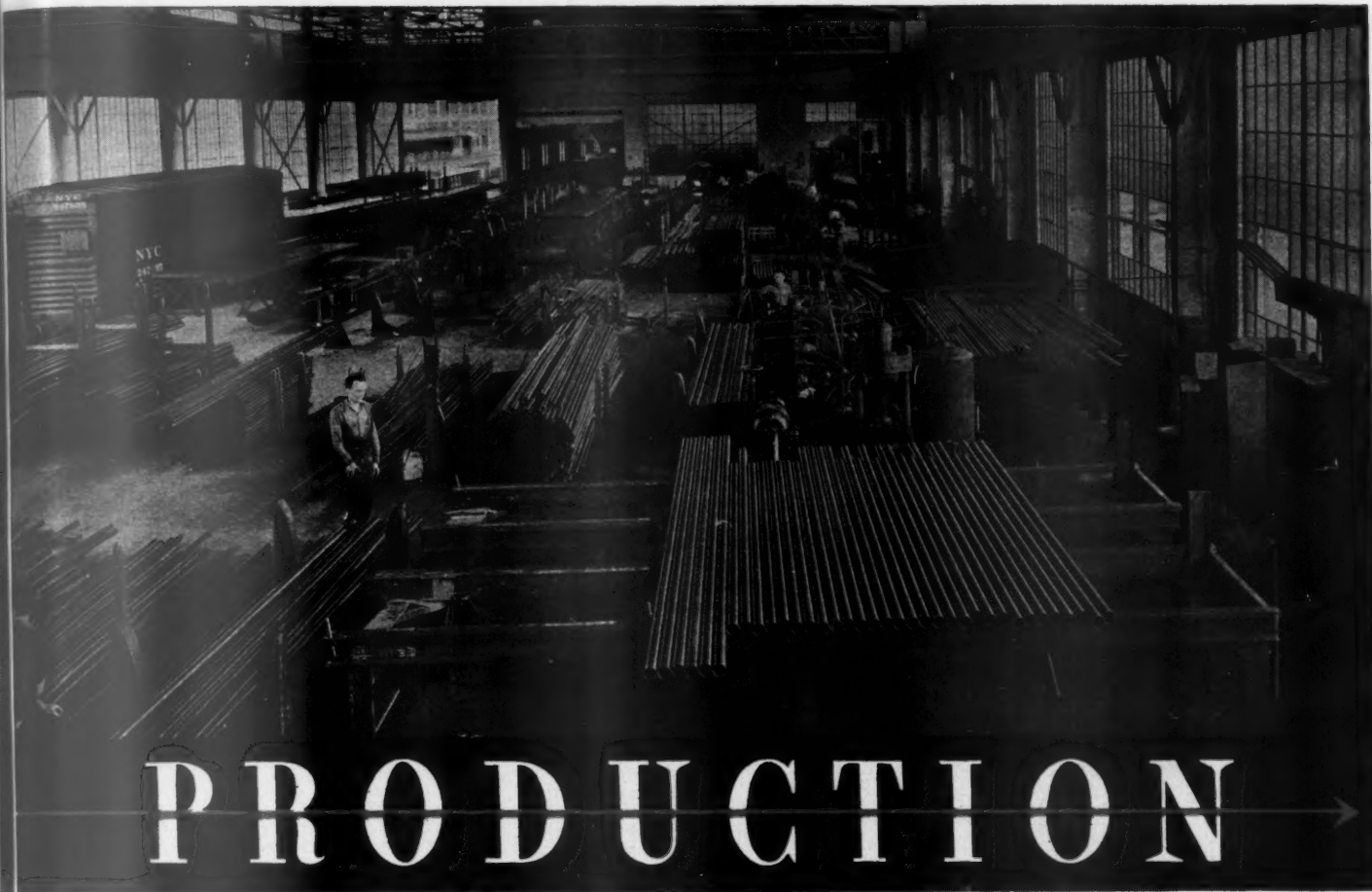
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**BOILER TUBE**

A Perfect Tube . . . . .

See the new controlled atmosphere annealed ELECTRUNITE Boiler Tube at Booth No. 10, Twelfth National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, Nov. 30th to Dec. 5th.

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# PRODUCTION

• When a coil of pickled flat-rolled steel enters the first of the series of modern machines that transform it into ELECTRUNITE Boiler Tubes, it begins a non-stop journey that ends only when the tubes are given final inspection and made ready for shipment.

This continuous travel—straight line production—is of special interest and vast importance to users of boiler tubes for this reason: Not one ELECTRUNITE Boiler Tube can escape a single step in processing—can miss any one of the many inspections through which it must pass before shipment to the user. Because of this, every ELECTRUNITE Boiler Tube is as perfect as modern machines and methods can produce.

The flat-rolled steel is clean and absolutely free from scale before it enters the first process in manufacture. It is inspected on both sides, double checked for gauge and hardness, and also for micro-structure. As the steel passes through the forming rolls, the burnishing effect further improves the surface.

Following electric resistance welding of the tubes come further inspection and tests. The tubes

move through the controlled atmosphere bright annealing furnace where they are normalized at a temperature above 1650° F. without producing scale or in any way disturbing the fine surface of the original cold-worked tubing.

This furnace automatically discharges into a new building devoted entirely to the production of boiler tubes. Additional tests are intermingled with the finishing operations, including hydrostatic test of 2000 lbs. Finally, each tube is given individual visual inspection.

ELECTRUNITE Boiler Tubes are the most thoroughly inspected boiler tubes made—perfect tubes—safe, economical tubes—each with a smooth, scale-free surface.

If you want the best in boiler tubes without increase in cost, specify ELECTRUNITE. Further detailed information will be sent upon request.

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WORLD'S LARGEST PRODUCER OF ELECTRICALLY WELDED TUBING  
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## Personal Mention

### General

E. BECKER, superintendent of motive power and equipment of the Green Bay & Western, at Green Bay, Wis., has been appointed mechanical inspector.

T. M. KIRKBY has been appointed superintendent motive power and equipment of the Green Bay & Western, with headquarters at Green Bay, Wis.

T. W. CARR, master car builder on the Pittsburgh & Lake Erie, with headquarters at McKees Rocks, Pa., has been appointed superintendent of rolling stock, with the same headquarters, to succeed S. Lynn, deceased.

S. J. HUNGERFORD, president of the Canadian National, has been appointed also chairman of the board, for a term of three years. Mr. Hungerford was born near Bedford, Que., in 1872 and entered railway service in 1886 as a machinist apprentice on the Southeastern Railway (now Canadian Pacific) at Farnham, Que. Completing his apprenticeship in 1891, he



S. J. Hungerford

worked at his trade at various places in Quebec, Ontario and Vermont for the Canadian Pacific. In 1894 he became charge-man for the same company at Windsor street, Montreal. Three years later he was promoted to the post of assistant foreman at Farnham shops. In 1900 he went to Megantic, Que., as locomotive foreman. The following year he was transferred to McAdam Junction, N. B., as general foreman. He then went to British Columbia for two years, being locomotive foreman at Cranbrook. In 1903-04 he was master mechanic for the Western division of the Canadian Pacific, with headquarters at Calgary, Alta., and in the latter year was promoted to the superintendency of the locomotive shops at Winnipeg, Man. From 1908 to 1910 he was superintendent of shops at Winnipeg. In 1910 he resigned from the service of the Canadian Pacific to become superintendent of rolling stock of the Canadian Northern (one of the predecessor companies of the present Canadian National), with headquarters at Winnipeg. In 1915 he was transferred to Toronto, Ont., in the same capacity. Two

years later he became general manager of the Eastern lines of the Canadian Northern and in the following year was appointed assistant vice-president of operation, maintenance and construction of the Canadian National, then in process of formation as successor to the Canadian Northern, with the same headquarters. In 1920 he became vice-president of operation, maintenance and construction of the Canadian National and Grand Trunk Pacific. In 1922 he was appointed vice-president and general manager of the two companies and, upon their merger into the present Canadian National System in 1923, he became vice-president of operation and construction of the system with headquarters at Montreal, in which position he remained until he was chosen also as acting president of the system in 1932 when the late Sir Henry Thornton retired. On the establishment of the board of trustees on January 1, 1934, Mr. Hungerford was appointed president.

### Master Mechanics and Road Foremen

W. P. PRIMM has been appointed assistant road foreman of engines, Baltimore division, of the Pennsylvania.

G. E. VAUGHN, special duty engineman, St. Louis division, of the Pennsylvania, at Terre Haute, Ind., has been appointed assistant road foreman of engines, Fort Wayne division, with headquarters at Fort Wayne, Ind.

### Obituary

JOHN GILL, who retired in 1910 as superintendent of motive power of the Chicago, Indianapolis & Louisville, died at his home at Chicago on August 25.

MOSES BURPEE, consulting engineer of the Bangor & Aroostook, and formerly chief engineer of this company, died at his home at Houlton, Me., on August 18, at the age of 89 years.

## Trade Publications

*Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.*

WELDED STEEL TRUCK FRAMES.—Lukenweld, Inc., division of Lukens Steel Company, Coatesville, Pa., describes and illustrates in an eight-page booklet welded steel truck frames for B. M. T. Lines multi-section cars.

HOLLOW SCREWS.—This catalogue, issued by the Allen Mfg. Co., Hartford, Conn., undertakes to assist in applying hollow screw advantages to machines on the floor and on the drawing board, and includes views of practical uses.

PIPE TOOLS.—Illustrated and described in the eight-page booklet issued by the Beaver Pipe Tools, Inc., Warren, Ohio, are the Model-A "Special" and the Model-A "Standard" pipe machines, having ranges of  $\frac{1}{8}$  in. to 2 in. and  $\frac{1}{2}$  in. to 2 in., respectively.

PERMUTIT BOILER FEEDWATER TREATMENT.—The chemicals used in Permutit internal boiler feedwater treatment and the feeds available are discussed in the eight-page booklet issued by the Permutit Company, 3320 West Forty-second street, New York.

FEEDWATER HEATING EQUIPMENT.—The construction, operation and principal advantages of the Worthington Type SA locomotive feedwater heating equipment are described in the four-page folder issued by the Worthington Pump and Machinery Corporation, Harrison, N. J. A diagram shows the course of steam and water through the equipment.

CRANES.—The Whiting Corporation, Harvey, Ill., has issued a 24-page illustrated catalog descriptive of the Tiger type of overhead electric traveling crane.

AJAX FORGING ROLLS.—Bulletins 91 and 91-P issued by the Ajax Manufacturing Company, Cleveland, Ohio, illustrate and describe Ajax wide adjustment forging rolls and forging roll products.

"OPERATOR'S INSTRUCTION BOOK."—This book, issued by the Landis Machine Company, Waynesboro, Pa., covers the Lanco Type R heads for threading machines, the Landmatic Type F heads for turret lathes, and the Landex Type J heads for automatic screw machines. It gives detailed data for the correct grinding and setting of Landis chasers and the care and operation of the three types of die heads.

JOURNAL BEARING DAMAGE.—The subject of journal bearing damage, its effects and remedy, is covered in an eight-page bulletin prepared for distribution by the Lewis Bolt & Nut Company, Minneapolis, Minn. This bulletin gives in condensed form a description of the methods followed and results secured in certain tests recently conducted in the laboratory of the Railway Service & Supply Company, Indianapolis, Ind., under the direction of K. W. Brossart of the Railway Service & Supply Company and H. W. Johnson of the Lewis Bolt & Nut Company. It is claimed in the bulletin that the tests proved conclusively that major or minor damage to the linings of plain journal bearings seriously interferes with proper lubrication and as a result tends to produce hot boxes and attendant operating difficulties and delays. Part II of the bulletin shows the favorable results secured with Macer journal bearing protectors in avoiding damage to journal bearings in transit.